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OF SELECTED ELECTRONICS FIRMS

by

DENNIS LEE HULL

Major, USAF

1992

400 pages of text

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The University of Georgia

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This dissertation documents the practices of firms operating in the highly competitive electronics field

service market. Companies were chosen based on industry rankings and on the recommendations of field service consultants and professionals; the six companies selected were: National Cash Register (NCR), International Business Machines (IBM), Amdahl Corporation, Hewlett-Packard Company, General Electric Computer Service, and American Telephone and Telegraph Company (AT&T) Computer Systems. The case studies document field service practices in the following areas: organization, strategy, performance measures, field operations, management information system(s), and service parts management.

Within- and cross-case analysis identified 24 management propositions and provided the basis for the development of a prescriptive field service model consisting of the following components: organization, strategy, operations flow, management information system, and service parts flow.

INDEX WORDS: Field Service, After-sales Service, Service Parts, Repair Parts, Electronics

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B.A., University of Central Florida, 1974

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DENNIS LEE HULL

Approved:

James F. Cox III Date 5/30/92
Major Professor

Saul Mathis Date 5/29/92
Chair, Reading Committee

Approved:

Gordhan L. Patel
Graduate Dean

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TABLE OF CONTENTS

Page

Page

Page

Page

LIST OF TABLES

* = tables that continue on additional pages

LIST OF FIGURES

* = figures that continue on additional pages

CHAPTER I

INTRODUCTION

Dissertation Overview

The service sector of the U.S. economy is rapidly growing. Shaw (1990) states that the service sector accounts for more than two-thirds of America's gross national product, for about 75 percent of the work force, and for up to 90 percent of new employment (p. 5). Heskett (1986); Johnston (1988); Gronroos (1988); and Armistead, Johnston, and Slack (1988) note that worldwide; major developed economies have experienced phenomenal growth in the service sector.

As our national and international economies shift from a production base to a service base, the importance of and emphasis on customer service is increasing. In response to this shift, the field of operations management has expanded both its teaching and research horizons to include not only the traditional concepts of production but also those of service operations. Companies are becoming increasingly aware of customer service as a competitive edge and, in many cases, as a competitive necessity. To explain the service phenomenon, numerous books and articles have been written covering the subject of customer service--topics range from

how to conduct customer research to the design of service facilities; from developing corporate service strategy to motivating individual service employees; from a view of service as close, one-to-one customer contact to one of "manufacturing in the field" (Levitt, 1972).

An important, and often overlooked, aspect of the service sector is the area of field service. Field service is concerned with the servicing and maintaining, by the supplier, of products used away from the manufacturer's or supplier's site (Voss, Armistead, Johnston, & Morris, 1985). In effect, field service represents a service organization within a manufacturing firm--providing customer service, a source of revenue, and a means for strategic competitive differentiation.

While little has been written specifically about the field service portion of the service sector, literature on both the general service sector and customer service has been increasing. Since field service, as its name implies, is a service function and customer service is a critical concern; literature on the service sector and customer service was reviewed for field service references and for guidance in directing the research.

This dissertation focused on research in the area of field service. The research was an exploratory effort and a case study research design was used. Industry leaders were chosen as subjects for the case studies to identify best practices. In this study a model of the field service

system was developed using system components suggested by Voss et al. (1985). Specifically these components are: organization (placement in the company hierarchy and internal levels of organization), strategy, performance measures, operations, management information systems, and logistical management of spare parts. To assist in the analysis of service operations, service blueprinting or flow charting was utilized to provide a visual display of service processes and their interrelationships. Specific interest was in the information channels within the field service organization and between the field service organization and other company functions. In addition to the model, field service management propositions, or empirical generalizations, are offered based on case analysis.

Importance of Research

To understand the importance of this research, it is necessary to understand the strategic importance of field service and the relationship of field service to the general category of customer service. The recognition of field service as a competitive edge parallels the realization that customer service has become a key competitive factor. Since little has been written on field service, the following sections provide an overview of customer service, trace the evolution of customer service into a key competitive weapon, present the traditional view of field service, and point out the recognition of the field service competitive edge. Additionally, the lack of field service research and the

importance of the dissertation to practitioners and researchers is discussed.

Customer Service

Levitt (1972) contends that every company has always been in the service sector. There is really no such thing as service industries--only industries whose service components are greater or less than those of other industries. The service sector of the economy includes not just the so-called service industries (e.g. banking, airlines, medical care) but also product-related services supplied by manufacturers and sales-related services supplied by retailers. "Rarely is customer service discretionary. It is a requisite of getting and holding business, just like the generic product itself" (Levitt, p. 51).

In 1982, Peters and Waterman (1982) reported the results of their survey of corporate excellence. Eight attributes emerged from the survey which the authors believed characterized successful, innovative, excellent companies. One attribute identified was a closeness to the customer--providing "unparalleled quality, service, and reliability" (p. 14). "Whether bending tin, frying hamburgers, or providing rooms for rent, virtually all of the excellent companies had, it seemed, defined themselves as de facto service businesses" (p. xxii).

Other studies indicate that customer service is increasingly becoming a competitive necessity for every

business. "Producing superior service is as important for coal companies as it is for IBM, as crucial for McDonald's as it is for management consultants" (Davidow & Uttal, 1989, p. xvii). Companies that recognize this competitive edge will be the winners in tomorrow's markets.

In a 1983 survey of 322 European executives, 75% strongly agreed that customer service would be essential to the future of successful companies (Davidow & Uttal, 1989). In 1987, the Gallup Organization conducted a poll of 615 senior executives of U.S. companies to gauge the relative importance of various factors in their competitiveness. The poll revealed that even manufacturing executives rated better customer service as important as higher quality (Shaw, 1990).

Customer Service--The New Competitive Edge

Customer service is heralded as the new competitive battleground (Davidow & Uttal, 1989); service is predicted to be the primary product of the 1990s (Albrecht & Bradford, 1990; Blumberg, 1989a). Winners of the 1990s will be companies whose services are customer-driven (Albrecht & Bradford, 1990); companies who reflect the "close to the customer" attribute identified by Peters and Waterman (1982).

Clark (1988) states: "In some sectors of manufacturing, particularly as products reach maturity, it may well be that the standard of product support [after sales service] is one of the few possibilities for product

differentiation" (p. 231). Davidow and Uttal (1989) draw a similar conclusion pointing out that in the evolution of most markets, competition progresses through stages based on features, cost, quality, and finally, service. New products and services initially compete on features. As competitors enter the market, feature for feature matching occurs and price becomes the competitive edge. As prices stabilize, quality is used to differentiate products. In time consumers grow to expect competitive features, prices, and quality. Consumers look for a new way to distinguish among core services and products--how they will be treated and how the product will be supported.

Katz (1988) argues that service has become so important that the traditional marketing mix must be updated from the traditional "four Ps" to "four Ps and an S" -- Product, Price, Place, Promotion, and Service (preface). Service (customer service) is a variable that management controls along with the four "P" variables.

An effective customer service organization can provide a distinct competitive edge and thereby contribute significantly to the success of a business. The following is a list of some specific contributions compiled from Bleuel and Bender (1980), Berry (1983), Takeuchi and Quelch (1983), Garvin (1983) and Bleuel and Patton (1986). Customer service provides:

1. Through customer interface and feedback:

(a) Greater knowledge of the product. Defects and field failures can be identified and used as the basis for quality and design improvements.

(b) Information about the use and misuse of a product. This serves as a basis for designing product information, promotions, and modifications.

(c) Validation of the accuracy and clarity of product instructions.

2. A means for company differentiation. Superior service makes the product more valuable to the customer.

3. Protection of the existing customer base and a potential for expansion. Superior service discourages switches to alternative suppliers while generating new sales leads.

4. The ability to meet and to maintain product performance objectives throughout the life of the product.

5. Income and profits when managed properly.

Field Service

Customer service offers a competitive edge; field service is one functional area of this competitive edge that has received little research attention and about which little is written. In many manufacturing businesses, the field service department and associated service parts inventories have been treated as by-products of the need to service customers with either repaired units or the necessary parts to perform their own repairs (Cook, Prather, & Testa, 1985). Service is viewed as of secondary

importance, a necessary evil utilized to handle customer complaints, product problems and to meet warranty requirements (Bleuel & Bender, 1980; McCafferty, 1980). Field service functions as an internal company department to provide adequate service at a minimum cost. Traditionally, the field service function has been viewed as an afterthought, or "add-on," at best.

Field Service--Recognition As A Competitive Edge

A recent trend away from the traditional view of field service has been to view it as a "service business." Companies are now becoming more aware of the contribution of field service to competitiveness and profitability (Berry, 1983; Bleuel & Patton, 1986; Cox, 1989). Well-designed, defect-free products can fail if follow-up service is not available. Although excellent customer service can rarely compensate for a weak product; poor customer service can severely detract from a superior product (Takeuchi & Quelch, 1983). No longer is field service an unpleasant duty; rather it is an essential feature of the product (McCafferty, 1980).

Customers are interested in follow-on service support for the items they purchase and use this as a criterion to determine from whom to buy the item (Bleuel & Bender, 1980; McCafferty, 1980; Voss et al., 1985). Additionally, close contact with customers is required to identify the changes in service needs over a product's life cycle. This close contact can be maintained by the field engineer--a person

second only to the customer himself in the knowledge of customer needs (Patton, 1989). Field service also serves as an early warning system for quality problems and product hazards.

A major trend in service management is the use of service as a strategic differentiator (Blumberg, 1989a). Companies will increasingly recognize the value of service as a mechanism for market penetration, market control, and profit generation. A major impact of this trend is predicted to be the elevation of service to a strategic line of business (p. 26).

Reflecting this "service-business" view is Bleuel's statement of the field service mission:

> 1. To contribute directly to profitability by providing customers with the technical, operational, and maintenance support necessary to obtain the maximum successful and continuous utilization of customer products.
>
> 2. To protect the existing customer base and to promote the sale of company products through:
>
> --the provision of superior field service, factory service, installation, and start-up support;
>
> --the performance of customer service engineering, failure reporting, analysis, and correction;
>
> --the establishment of a spare parts and consumables system to assure satisfaction of requirements for operation, maintenance, and repair of products;
>
> --the establishment of a responsive, efficient, and cost effective service distribution network and support system; and
>
> --the performance of studies and evaluation to assure product maintainability, serviceability, and analysis of life-cycle characteristics during the stages of

> product development, testing, and customer use. (Berry, 1983, pp. 45-46)

As the importance of field service is recognized and as competition increases, greater attention is being focused on improving customer service levels to keep existing customers and attract new ones.

Lack of Field Service Research

In 1980, the American Management Associations sponsored a research study by Bleuel and Bender (1980). This study was described by the authors as a "pioneer effort to examine the extent and nature of planning for the delivery of product [field] service" (p. 6). Bleuel and Bender (1980) felt research in this area was necessary due to the growing importance and rapid growth of product service and stated:

> Up to now there has been no baseline data on planning for product service. Industry, aware of the growing competitive importance of technical service, is interested in increasing the effectiveness of service operations. Marketing and service executives with responsibility for the allocation of service resources clearly need facts and data on service planning practices. Such a data base will make it possible for them to compare their individual situation with those of others, and presents alternative modes of planning that may not previously have come to mind. (p. 6)

The Association For Services Management International (AFSMI) recognized this same lack of baseline product service data for the electronic products service industry. In 1987, in conjunction with Arthur Andersen & Co., AFSMI began a program called "Linking Service Strategy to the Bottom Line." The objectives of this program are "to identify, quantify and track the performance of leading high

technology service organizations based on an extensive series of financial and operational bench mark measures" (AFSMI and Arthur Anderson & Co., 1988).

At a Field Service Materials Education and Training Roundtable sponsored by Digital Equipment Corporation, October 6-7, 1987, field service representatives from several major electronics manufacturers (Amdahl, Control Data, DEC, Honeywell Bull, IBM, Prime, Unisys, Xerox) specified the need to elevate the role of field service within the electronics industry and to improve the capability of service parts management. A summary of field service research needs was also compiled. Included in these needs were: documentation of management techniques for field service inventories, identification of critical field service success factors, and industry case studies (Pittiglio, Rabin, Todd, & McGrath, 1987).

The need for field service research is recognized by major corporations and management associations. Service executives and planners must identify and capitalize upon their strengths in order to achieve and sustain superior financial and operational performance (AFSMI and Arthur Andersen & Co., 1988).

Importance of Study--Practitioners

Field service can play a critical role affecting company competitiveness, profit, sales support, and user base support (Voss et al., 1985). Although often a part of a manufacturing or supply business, it is an important

service operation. Field service managers have recognized the lack of information in this area and have called for research. This dissertation addresses some of the identified research needs and provides a contribution to the field service body of knowledge. By analyzing data within and across case studies, both common and innovative field service management techniques and practices were identified. For field service practitioners, presentation of industry best practices provides an opportunity for analysis, for comparison, and for possible incorporation of these practices into their business operations.

Importance of Study--Researchers

As with the service sector in general, little research has been undertaken in the area of field service. Chapter II provides a review of existing field service literature and research efforts. A lack of literature and integrative, systematic research is noted. Conversations with field service practitioners, consultants, and representatives of the Association For Services Management International and the National Association of Service Managers confirmed the results of the literature review. This dissertation is therefore an exploratory effort. Babbie (1975) explains that exploratory studies are essential whenever a researcher is breaking new ground and they can almost always yield new insights into a topic for research (p. 51). For researchers, this dissertation provides a systems view of

the field service function, contributes to the field service body of knowledge, and identifies areas for future research.

Dissertation Focus

Electronics Industry

Field service is becoming recognized by manufacturers as an important competitive weapon. Surveying 170 diverse manufacturers in the United Kingdom, Clark (1988) found that electronics companies placed a higher importance on field service than other manufacturers. Additionally, the U.S. Department of Commerce (1989) predicts that the electronics (and specifically the computer) industry will increasingly shift emphasis away from manufacturing toward after-sale maintenance. Thomas (1987) describes field service as the "key to *customer satisfaction*" in the computer/electronics market (p. 7).

In the electronics industry, significant market and competitive developments in field service management occurred during the mid to late 1980s (Blumberg, 1989a). Service-based competition assumed a critical role in company profitability. For the electronics products service industry, currently 15-25% of a vendor's revenues are derived from service and the service market is estimated to be over $20 billion. This service market is estimated to grow to nearly $50 billion in the 1990s and to provide up to 30% of corporate revenues. The electronic products service industry has experienced a decade of sustained growth at a rate that places it among the leading service sectors in the

U.S. economy (Association For Services Management International and Arthur Andersen & Co., 1988).

In an exploratory research effort such as this dissertation, leading companies are selected to provide insight into "best practice." Case studies of leading companies in the highly competitive electronics field service environment provide important insight into the management of the field service function and service parts.

Research Questions

Research questions for this study are as follows:

1. How is the field service function organized?

2. What is the field service strategy and how does that strategy contribute to the overall company strategy?

3. What performance criteria, standards, and measures have been set to evaluate field service performance?

4. What service processes make up field service operations?

5. How is the management information system organized within the field service organization and what information interfaces exist with other company functions?

6. What logistical techniques are used to manage service parts?

Organization of the Dissertation

The general research area is defined and the importance of the research is described in Chapter I. Chapter II provides a review of field service literature. In Chapter III, the research methodology and design are discussed in

detail. Chapter IV consists of six case studies. Chapter V contains the within-and cross-case analysis of the case data and literature as well as the field service management propositions and model. Finally, Chapter VI contains the dissertation summary, conclusions, limitations, and suggestions for further research.

CHAPTER II

REVIEW OF PRIOR RESEARCH AND RELEVANT LITERATURE

Introduction

A computer search of the Abstracted Business Information (ABI)/Inform database produced six articles using the key words: "field service," "product support," "service parts," "repair parts," and "spare parts." Dick Berry, Professor of Management at the University of Wisconsin and member of the National Association of Service Managers (NASM) education committee, suggested some of the key words for the search. The ABI/Inform database was chosen by the library search analyst as the most likely to provide information sources on the topic area of field service.

Few books specifically focus on field service and service parts (Berry, 1983; Bleuel & Bender, 1980; Bleuel & Patton, 1986; McCafferty, 1980; Patton, 1984; Patton, 1986); much of the information presented is "generic" operations management practices such as economic order quantity (EOQ), facility layout, control charts, basic statistics, and simulation.

Few in-depth case studies of company field service operations were found. Voss, Armistead, Johnston, and Morris (1985) provide two case studies: North West Gas and

Computer Technology Ltd. Field service organization, field engineer scheduling, quality control, management information needs and performance measures are among the topics discussed for each company.

Noting the lack of research on service parts management, Lee and Steinberg (1984) present six case studies of service parts management practices. Six firms were selected based on service parts management experience and diversity of operating environments: automotive operations, medical diagnostic equipment, computers, watches, oil field equipment, and office copy machines. Five common elements of managing service parts were used for analysis: identification of service parts, business planning and strategy, field supply, ordering and stocking policies, and supplier interface. Cross-case analysis provided twelve common principles of service parts management. The authors emphasize that their study addresses current service parts practices and seeks to define a common framework for the study of service parts management.

Peters (1983) discusses techniques used by NL Shaffer to design a spare parts department. Four areas of the business were identified as critical to spare parts management: warehousing, inventory control, sales, and purchasing. These four areas were placed under the control of a spares manager. Besides the organizational structure, procedures to establish close coordination with

manufacturing, materials management, and engineering were discussed and performance measures were suggested. Based on his experience with business jet spare parts, Giuntini (1983) offers the reader "a better understanding of how the functional areas of Marketing, Finance, Operations, and Human Resources are managed within the context of running a service parts business" (p. 29). Cox and Snyder (1986) discuss a systems approach for examining distribution systems. They provide a systematic procedure for improvement and present a case study illustrating a centralized direct-delivery distribution system that has application to the spare parts market.

By far the most common subjects of field service articles were service parts and parts-related topics: forecasting techniques, parts/manufacturing interface, and general inventory management. In some instances, company specific approaches were presented. Except where previously noted, the major shortcoming of the existing field service research and literature is the general lack of a system focus.

It was noted in Chapter I that field service is one unique aspect of the service sector. Since little has been written specifically on field service, literature on the service sector was reviewed for field service references and used as a guide to direct the research. The relevant literature is organized according to the field service system components that were previously identified:

organization, strategy, performance measures, operations, information systems, and management of service parts.

Organization

Commenting on the status and position of the field service organization in the company hierarchy, McCafferty (1980) notes:

> Historically, most service operations that are a part of a larger company started as cost centers. The company saw the need for a department to provide certain services to customers, and set up a "service department." This department usually reported to the sales or marketing group, and was regarded as one of the evils necessary to answer the complaints of customers. (p. 5)

In the past, the service parts organization was a place to exile poor performers (Patton, 1984); service operations were traditionally subordinated to other company divisions (Berry, 1983).

Today, with an estimated $115 billion invested in service parts by the Fortune 500 companies alone, the service parts function commands a higher status (Patton, 1984). The increasingly complex technology of today's products has increased the dependence of the customer on the manufacturer's service organization (McCafferty, 1980). Blumberg (1989a, 1989b) and McCafferty (1980) identified trends in product service during the 1980s: a shift from cost center to profit center; from decentralized to centralized operations. In the 1990s, Blumberg (1989a) predicts a further shift will be required: from independent profit center to a strategic line of business.

Berry (1983) describes six organizational approaches to product service management: privately owned service companies, independent distributors and dealers that offer product service, company-owned service centers, a national service force, servicing by mass merchandisers (Sears, for example), and servicing through original equipment manufacturers (Stanadyne supplies as well as services diesel fuel injectors for General Motors).

In their research, Lee and Steinberg (1984) found that the company organization for service parts varied over the six companies studied. NCR utilizes a separate service parts organization centralized at the Worldwide Service Parts Center. SEIKO, Rockwell and 3M service parts support functions are organized as service divisions; NL Schaffer treats service parts as a separate product line supported by three divisions. Technicare, a medical equipment company, employs about one third of its employees in a customer service division that manages field service and spare parts.

Although little information is available on the field service organization, some general findings emerge: The organization of the field service function varies. The field service function's placement in the company structure varies. Trends have been noted from cost center to profit center and from decentralized to centralized operations.

The increasing importance of field service to company competitiveness requires an effective organizational structure. Current literature describes trends and variety

but provides no detailed organizational descriptions; a study of how leading firms organize the field service function provides not only detail but also "best practice."

Strategy

Service

Warren Blanding, editor and publisher of the "Customer Service Newsletter," stated:

> The trend toward consumerism, the changing competitive climate and the recent recession all have forced companies to reexamine their relationships with customers. As a result, customer service has become a strategic tool. It used to be regarded as an expense. Now it is seen as a positive force for increasing sales--and for reducing the cost of sales. (Albrecht & Zemke, 1985, p. 9)

Blanding's comments contrast sharply with the traditional treatment of customer service as a marketing gimmick or as a costly by-product of manufacturing, requiring little planning. Customer service is now recognized as essential to the health of a business, as a competitive edge, and as the new competitive battleground of the 90s. Service planning and service strategy formulation are now necessities. A definition of service strategy is provided by Albrecht and Zemke (1985), "a distinctive formula for delivering service; such a strategy is keyed to a well-chosen benefit premise that is valuable to the customer and that establishes an effective competitive position" (p. 64). A service strategy allows a company to position its service in the marketplace, provides a unifying direction for the organization, and lets service

front line personnel know what is important in the organization (p. 67).

Superior service is directly linked to service strategy. Davidow and Uttal (1989) contend that the development of a service strategy is the first and most important step toward outstanding service. Albrecht and Zemke (1985) conducted an extensive study of service companies and identified three features of outstanding service organizations; a well-conceived strategy for service was the number one feature identified.

Service strategy begins with knowing your customer (Albrecht & Zemke, 1985; Bleuel & Patton, 1986; Davidow & Uttal, 1989; Heskett, 1986; Katz, 1988). Segmenting, or grouping of customers, is also important for service strategy development. Since service organizations can have considerable difficulty delivering more than one "product," more than one type or level of service, at one time, market segmentation is more important to service organizations than to product manufacturers (Heskett, 1986, p. 7). He states, "Groups of customers must be singled out for a particular service, their needs determined, and a service concept developed that provides a competitive advantage for the server in the eyes of those to be served" (p. 7, 9).

> Davidow and Uttal (1989) reached a similar conclusion: The elements of strategy sound simple to achieve. Developing a strategy means nothing more than segmenting customers according to their service expectations, finding out exactly what those expectations are, and adjusting customer expectations to match your ability to deliver service. (p. 47)

To adjust customer expectations, a communications plan (e.g. advertising and salesmen's promises) must be developed that will influence customers to expect a little less service than they will get. For example, if you can respond in two hours to a repair call, promise three. A common goal of service leaders is to under-promise and over-deliver (p. 80).

Heskett (1986) provides strategic tools and conceptual approaches to assist in service strategy formulation. He believes the continued use of concepts and strategic models from the manufacturing sector hinders the development of service sector strategy. To avoid the product-oriented concepts and models and to allow the service sector to secure a lasting competitive advantage, Heskett (1986) developed a "strategic service vision" based on years of research on service industries. Leading service firms are characterized by a strategic service vision consisting of: a targeted market, a well-defined service concept, a focused operating strategy, and a well-designed service delivery system. Customer segments must be targeted for a particular service. The service concept provides an answer to the familiar question, "What business are we in?" The service concept describes how the organization would like to have its service perceived by customers, employees, and shareholders. The operating strategy is formulated to achieve the service concept and the service delivery system

does what its name implies: delivers the service to the customer.

Field Service

The ability to service one's own product is recognized as a competitive advantage (Bleuel & Bender, 1980; Cox, 1989; McCafferty, 1980; Voss et al., 1985). Descriptions of the operating strategy to achieve this field service competitive advantage are lacking. Lee and Steinberg (1984) reported that five of the six companies they studied believed a competitive advantage in their markets depended on the ability to service their equipment in the field. However, no description of the overall field service strategy to achieve this competitive advantage was provided.

Blumberg (1989a) notes an increasing commitment to strategic service management and a trend to treat the field service function not only as an independent profit center but also as a strategic line of business. This trend will require service executives to establish a strategic planning and marketing staff to focus on the special requirements for marketing, merchandising, and selling service (p. 26). He predicts that in the 1990s, as field service in the electronics industry increases in strategic importance, long term strategy and concepts will (and must be) developed (p. 29).

Summary

Service strategy is critical to a service organization: research indicates that strategy is directly linked to

superior service (Albrecht & Zemke, 1985; Davidow & Uttal, 1989; Shaw, 1990). Strategy provides direction and customer focus for an organization. Historically, service strategy has either been neglected or developed using misapplied manufacturing-based models. The belief that product-oriented strategy concepts and models are not applicable to the service sector has led to the recent development of new tools for service strategy formulation (Heskett, 1986; Shaw, 1990).

In his article, "Future Shock in Service: Repositioning for the Decade of the '90s," Blumberg (1989a) identifies and discusses five key factors that will impact the electronics field service environment in the 1990s. First, technological advances, in the form of extremely high density integrated microprocessor circuitry, are increasing the modularization of components allowing a "remove and replace" service approach. Secondly, the increasing trend towards data networking often involves the inter-linking of a variety of machine types from various manufacturers. Electronics vendors must be able to support and service not only their products but also those of other companies. A third key factor is the focus by customers on quality (primarily rapid response and minimization of downtime) of field service and service delivery. Two factors have contributed to this quality focus: the increased dependence of users on electronic technology and the contracting out of service responsibilities due to the growing cost of internal

maintenance staffs. In both Europe and the United States, efforts are underway to develop specific standards for service quality. The focus on quality of service leads to a fourth factor: potential customers now view service offerings as a primary competitive differentiator between vendors. The fifth and final factor is the rapidly improving technology for service management, delivery, and control. To remain competitive, service companies must adopt these technological tools. Integrated field service management system software, hand-held terminals to facilitate communication between field engineers and headquarters service management, and artificial intelligence applications for diagnostics are just a few examples of technology applications. Blumberg (1989a) believes these factors will result in significant changes in service organizations and operations in the 1990s and will require service executives to develop long term strategies to meet these changes.

In the mid to late 1980s, field service in the electronic products service industry was recognized as a vital company business center and a shift from cost to profit center operations began (AFSMI and Arthur Andersen & Co., 1988; Blumberg, 1989a). The trend toward operating field service as a profit center and the significant changes predicted in the field service environment of the 1990s are forcing field service managers to assume a new role involving strategy planning and formulation. Field service,

now recognized as a competitive weapon, requires a strategy to provide the necessary superior level of performance. This new operating environment poses a challenge to many companies and field service managers; the documentation of field service strategy designed to address the environment of the 1990s is currently lacking.

Performance Measures

Service

The University of Warwick (United Kingdom) has identified a lack of research on service performance measures and is currently undertaking a multi-disciplinary (operations management and management accounting) research effort to develop a range of performance measures for the service sector. One product of this effort is a study by Fitzgerald (1988).

Fitzgerald (1988) notes the dysfunctional behavior of managers based on the dominance of accounting measures in performance measurement and references the work of Kaplan and others in the area of research on manufacturing performance measurement:

> Empirical evidence, from the manufacturing sector, has shown the dominance of accounting measures in performance measurement, in particular the reliance on short-term profit based measures. This can lead to opportunistic behavior by managers acting in their own interests rather than the organizations' interests. (p. 348)

For the service sector, this application of conventional "single dimensional profit measures" must be avoided (p. 347). Instead a wider range of performance

measures is needed: reliability, flexibility, performance of service specifications, delivery speed, service speed, and resource utilization measures such as throughput, waste, capacity, and slack. Fitzgerald (1988) also suggests that quantification of service performance measures is difficult; absolute quantification may not be a feasible goal for some measures (p. 346). Lash (1989) advocates a similar position:

> In superior service companies, targets and objectives are not purely financial but also include specific measures of service delivery, expressed in numeric or financial terms where possible. Customer satisfaction and service delivery matter in these companies and many make these targets and objectives top priority. (p. 101)

Performance measures are recognized as critical to the success of a service business. "An intimate and objective knowledge of how you are doing--in the customer's eyes--is critical" (Albrecht & Zemke, 1985, p. vi). Performance standards must be based on the customer's service expectation (Lash, 1989); therefore the origin of performance measures is the customer. The goal of customer market research is a prescription for success in marketing and delivering your service product (Albrecht, 1988). This prescription can take the form of a customer report card that defines key attributes of the total service experience the company offers. Albrecht (1988) explains:

> The starting point for the measurement of service is the customer report card you discovered during the market research process. The attributes of your service package most desired by your customers must

> become your guideposts for assessment and correction of the outcomes of the work. (p. 170)

The customer report card yields key attributes of the service product that customers consider important. By converting service attributes into measured variables, the customer report card becomes an instrument to set up the means for gathering data from customers, to set up the means to process data, and to create a format for presenting results in understandable form (p. 219).

Services present some unique quality control and quality measurement problems. The moment of truth, or personal contact between the customer and organization, is dependent upon the particular person performing the service. The customer's quality perception is based on this moment of truth (Albrecht, 1988; Beckwith & Fitzgerald, 1981; Booms & Bitner, 1981). Zeithaml, Parasuraman, and Berry (1990) refer to this as heterogeneity: service performance (and therefore level of service quality) can vary from producer to producer, from customer to customer, and from day to day. Services have also been described as intangible, or as providing "something" that the user cannot easily and objectively measure (Jones, 1988; Zeithaml et al., 1990). Finally, the production and consumption of many services are inseparable. The production and consumption occur simultaneously, with the customers observing and evaluating the production process as they experience the service (Voss et al., 1985; Zeithaml et al., 1990).

"Those who have managed in both product- and service-oriented firms repeatedly state that quality control in service firms presents the greater problem" (Heskett, 1986, p. 57). While considered more difficult than manufacturing quality management, service quality management is a requirement for today's business world. Associated with quality management is the measurement of quality performance. In the marketing of service, quality control can only be ensured by monitoring, observation, and feedback (Albrecht, 1988; Booms & Bitner, 1981; Andrews, Drew, English, & Rys, 1987). Zeithaml et al. (1990) state:

> Executives who are truly dedicated to service quality must put in motion a continuous process for: (1) monitoring customers' perceptions of service quality; (2) identifying the causes of service quality shortfalls; and (3) taking appropriate action to improve the quality of service. (p. 35)

Noting the problems of service quality management and the lack of service quality literature, Zeithaml, Parasuraman, and Berry (1990) undertook research to determine "service quality insights that would transcend the boundaries of specific industries" (p. 17). They began their studies in 1984. Four service areas were investigated: retail banking services, credit card services, securities brokerage services, and product repair and maintenance. Since some commonalities emerged from the interviews, the authors felt a general model of service quality could be developed. They cite as the most important insight the following:

> A set of key discrepancies or "gaps" exists regarding executive's perceptions of service quality and the tasks associated with service delivery to consumers. These gaps can be major hurdles in attempting to deliver a service which consumers would perceive as being of high quality. (Parasuraman, Zeithaml, & Berry, 1984, p. 6)

Zeithaml et al. (1990) also identified ten service quality dimensions:

1. Tangibles: Appearance of physical facilities, equipment, personnel, and communication materials.

2. Reliability: Ability to perform the promised service dependably and accurately.

3. Responsiveness: Willingness to help customers and provide prompt service.

4. Competence: Possession of the required skills and knowledge to perform the service.

5. Courtesy: Politeness, respect, consideration and friendliness of contact personnel.

6. Credibility: Trustworthiness, believability, honesty of the service provider.

7. Security: Freedom from danger, risk, or doubt.

8. Access: Approachability and ease of contact.

9. Communications: Keeping customers informed in language they can understand and listening to them.

10. Understanding the Customer: Making the effort to know customers and their needs.

These same authors (Parasuraman, Zeithaml & Berry, 1986) developed SERVQUAL, a multiple item scale for measuring customer perceptions of service quality. The

previously identified quality dimensions were used to derive the SERVQUAL scale.

Lyth and Johnston (1988) discuss three service quality frameworks and associated performance parameters developed by Morris and Johnston; Juran, Gryna, and Bingham; and Gronroos. Morris and Johnston explored the difference between manufacturing and service on the basis of tangible and intangible dimensions of each system. A scheme for classifying quality characteristics was developed by Juran, Gryna, and Bingham. Five major classes were identified: technological, psychological, time-oriented, contractual, and ethical. Gronroos identified two basic dimensions of quality: technical, or what the customer receives as a result of the service and functional, or how the service is provided. The work of Zeithaml, Parasuraman, and Berry (1990) is more extensive and in general, includes and expands upon the other works.

Field Service

Voss et al. (1985) proposes three sets of field service performance measures: hard performance, soft performance, and cost. Machine reliability and availability are examples of hard performance; they are easily quantified and measured. Soft measures are elements that influence a customer's perception of service; examples include attitudes of the service personnel and the perceived quality of service. Cost measures address level of service/cost tradeoffs.

Recognizing the hard and soft measures of quality, Hewlett-Packard has developed two measurement systems. Davidow and Uttal (1989) explain:

> The FURPS system concentrates on the product attributes of Functionality, Usability, Reliability, Performance, and Supportability. The AART system focuses on the quality of H-P's relationships with customers and measures the company's ability to Anticipate customer needs before they become problems, to make Available whatever's required to meet those needs, to Respond quickly and effectively, and to ease Transitions from one generation of products to another. Now H-P is applying versions of FURPS and AART to its field service operations. (p. 202)

Clark (1988) performed a survey of after sales service of manufacturing companies in the United Kingdom. The 170 companies that responded represented a broad sampling of manufacturing interests: shipbuilding, vehicles, aerospace equipment, electronics, chemicals, metal products, petroleum, and various engineering firms. The companies were asked to rank order a range of measures: (a) spares "first pick" availability, (b) order process time, (c) order completion, (d) service engineer response, (e) mean time between failure (MTBF), (f) mean time to repair (MTTR), and (g) individual service engineer performance. The companies identified as most important spares availability and service engineer response time. However, for the two most important service performance measures, only 50% of the companies set targets for and actually measured spares performance; only 65% set targets for engineer response time. Customer service audits, which provide important feedback on service

performance from a customer perspective, were used by only a third of the companies.

Summary

Service sector performance measurement is generally considered more difficult than measurement of manufacturing performance. This measurement difficulty is attributed to three characteristics of services: heterogeneity, intangibility, and inseparability. Quantification of service performance measures is often difficult and may not be a feasible goal for some measures.

Although service performance standards are hard to set, measures of performance are recognized as critical to a service business. Customer feedback on service provides a means for assessment and correction. Service quality has become a central business issue; the 1980s have been called "the service-quality awareness decade in the United States" (Zeithaml, et al., 1990, p. 172). Models of service quality and means to set standards and measure performance have been suggested by various authors.

Recognition of the importance of service performance standards must be followed by implementation of customer service measures. Clark's (1988) research findings, based on a survey of after sales service of 170 companies, indicates that successful implementation does not always follow recognition: targets for performance measures were often lacking, formal service policies and standards were often not communicated beyond the senior manager level,

relatively few companies had clear customer complaint procedures, and performance in resolving complaints was not monitored or controlled.

Currently the use of accounting performance measures has led to dysfunctional behavior of managers. Managers, whose rewards (esteem, bonuses, promotion) are based on divisional performance, focus on short term performance measures (e.g. productivity, profit) which often conflict with long term organizational objectives (Fitzgerald, 1988). Fry and Cox (1989) also discuss the conflict between local and global (overall company) performance measures. Their discussion focuses on the manufacturing environment but the concepts developed apply to any type of firm. The hypothetical and actual company examples that are provided illustrate how local efficiencies can negatively impact company (global) performance.

In general, a wide range of service performance measures is needed; measures that recognize the hard, soft, and financial dimensions of service performance. Fitzgerald (1988) points out: "Although there is some agreement that a wider range of performance measures is necessary there is no agreement as yet upon what these measures should be . . . ." (p. 346). Fitzgerald (1988) suggests that service performance measurement research, examining companies' practices and utilizing a multi-disciplinary approach, is required. Fry and Cox (1989) also advocate research to determine the proper dimensions and relationships for a

firm's comprehensive performance system--a system where local measures exhibit a direct cause-and-effect link to global measures.

Service Operations

Literature providing detailed descriptions of field service operations was lacking. Thomas (1987) provides an overview of the field service organization and suggests four major functions: field operations, technical support, dispatch, and information management. Field operations consists of the field engineers who diagnose and repair defective equipment. Technical support is provided by the most experienced technicians, usually from a centralized location. These technicians perform remote diagnostics, help field engineers solve more difficult problems, and assist customers directly in solving operational problems. The dispatch center reacts to customer trouble calls and assigns the correct field engineer to solve the customer's problem. Finally, data on field operations must be recorded and reported by the field engineers. This data is used by the field service organization for various purposes such as customer billing, inventory control, and creation of a technical database.

Higgins (1989) provides guidance on establishing a customer (technical) support center. He proposes a series of questions designed to evaluate the need, scope, and objectives of the center. Customers of the center may include field engineers, end users of equipment, sales

personnel, or a third party service organization handling a company's product in remote areas. Staffed by technical experts, a well run customer support center can provide improved service response, satisfied customers, and ultimately serve as a valuable marketing tool.

For this dissertation's case studies, a means of analyzing the data collected on detailed service operations is desirable. Albrecht and Zemke (1985) introduced the concept of a "cycle of service." A cycle of service is the continuous chain of events the customer goes through as he or she experiences a company's service. The cycle consists of moments of truth which form a chain of events and which may interact with numerous organizational departments. A cycle of service provides a visual, integrated method for analyzing a portion of the service operation provided by a company: the customer/field service interface.

A similar method for service analysis is a service blueprint. The service blueprint allows a service designer to identify the processes involved in the delivery of the service, isolate potential failure points in the system, establish time frames for the service delivery, and set standards for each step that can be quantified for measurement (Heskett, 1986). Zeithaml, Parasuraman, and Berry (1990) call service blueprinting "the most promising tool for service design" (p. 158). They further state that few organizations actually used the tool in the 1980s and the real opportunity for blueprinting lies ahead. Both of

these methods represent an adaptation of flow-process charts or flow charts to the service operation.

No matter what the process is called, cycle or blueprint, a means of visually diagramming the service process provides an important (though under used) technique for system analysis. For this research, "service blueprint" provides a wider scope of analysis and will be used as the descriptive terminology. The service blueprints developed in the case studies provide a detailed description of service operations. These blueprints, providing an overview of the service flow, its components, and interrelationships extend the current limited descriptions of field service functions found in the literature.

Management Information System

Service

According to Heskett (1986), information and the ability to manage information are critical to the service sector:

> The most valuable assets that many service firms possess do not even appear on their balance sheets. They are the database and associated information technologies. Both cost a great deal to assemble and maintain, and together they offer a variety of opportunities both for exploring the needs of customers whose profiles a database may contain and for developing new services to meet those needs. (p. 114)

Procter and Gamble's hot line (800 number) acts as a problem solver and value-added service for customers while collecting data that can lead to service improvements. Other companies, such as IBM, Sony, General Electric, and

Whirlpool, have found that service information feedback allows them to discover the demographics of their marketplace, problems with new products, customer concerns and needs, the life expectancies of their products, the ability of consumers to effect their own repairs, and the potential of proposed new products (Albrecht & Zemke, 1985).

The information flow from the customer must be supplemented by an internal information flow. Hopkins and Bailey (1970) note that operational problems in customer service frequently are due to failures of communication within the company. Bertrand (1988) points out that communication between sales and service can mean the difference between a satisfied or disappointed customer.

Field Service

The activities of the field service function can affect (and are affected by) most departments of a company. Field service is the major source of information on how products operate in the field. Many, if not most, product improvements are the result of service feedback to engineering. The service function can identify product hazards as they occur and alert both the customer (safety) and the company (liability exposure). How a product is designed and manufactured affects service maintainability and supportability. The sales and marketing departments must be aware of the capabilities and limitations of field service operations when offering products to the customer. Over-promising of service leads to customer dissatisfaction,

discredit of the field service organization, and the loss of future sales. Field service engineers, who generally see the customer more frequently than sales personnel, can often provide leads to sales and marketing concerning customer upgrades, system expansions, or other product needs.

The increasing competitive importance of field service makes communication between service and the sales, marketing, legal, engineering, and manufacturing departments vital (McCafferty, 1980). The field service management information system (MIS) must be integrated into the company MIS to facilitate this exchange of information.

Patton (1986) states that a field service organization operates in both internal and external environments and reiterates the critical need for information flow and management. Field service needs information from design and production so that proper equipment and software are available to service customer needs. A field reporting system is required to assess customer satisfaction, promote efficient and economical operation, and provide quality and design improvement.

Summary

Information and information management are critical to any business. For customer service, information flow is critical. Customer problems and complaints must be directed to the person or department most able to solve them; rapid response is necessary to prevent the loss of customers.

Field service provides information to the customer on proper equipment use and technical changes. Field engineers can also assess customer satisfaction face-to-face as well as provide information on design and quality problems. Communication between field service and other company departments is critical. Field service provides the customer interface element, or using Heskett's (1986) terminology, the service delivery system. If the delivery system is not coordinated with the rest of the company, company service fails. According to Thomas (1987), information management helps to control the size and nature of the customer's trouble. This results in a bottom line benefit in terms of customer satisfaction (p. 37).

The importance of information flow and management in the service environment is recognized. The use of toll-free, 800 numbers to determine customer satisfaction, solicit customer comments, and develop a customer database has been noted. For field service, communication between the field service organization and other company functions is a necessity. Lacking, however, is a description of what information should be exchanged and how that information flows and is managed within the field service function and between field service and other company departments.

Parts Management

The critical dependency of field service on parts availability accounts for the large number of articles on service parts encountered in the literature review. These

articles have been classified into two major subject areas: inventory management and forecasting.

Inventory Management

In December, 1982, the American Production and Inventory Control Society (APICS) sponsored a workshop focusing on service parts management. The APICS workshop participants concluded that serious problems exist with service parts management as it is currently practiced (Lee & Steinberg, 1984). Specific problems that were identified included:

1. Many companies load the manufacturing requirements of service parts directly into the MRP system or the master production schedule without any approval or review.

2. Service parts are often given low manufacturing priority; most of the manufacturing capacity is allocated to end items. Low priority consistently leads to customer dissatisfaction due to the lack of service parts.

3. Logical analysis of initial provisioning (spares stocking for initial failures of new equipment) of service parts and "last buy" (end of support) life cycle procedures generally do not exist.

As a result of this APICS workshop, Lee and Steinberg (1984) examined the service parts management of almost 100 companies throughout the United States. They found that although significant advances have been made in consolidating and coordinating manufacturing, distribution, financial, engineering, marketing, and other activities of

the firm (through Material Requirements Planning (MRP) and MRPII), service parts management was generally ignored:

> While much of the literature . . . was concerned with inventory management for items which are expendable or consumable, little attention was paid to problems faced by those companies where major portions of inventory investment consist of service parts which move in a cycle from manufacturing through stages of installation and removal, repair or rework, stock storage, and with in-transit and distribution states intertwined. (p. 1)

Service parts inventory presents special problems in control. The inventory frequently represents a very large investment in a highly fluid state. A repairable item can be found in a wide variety of locations and can exist in several states (e.g., serviceable, unserviceable, or in process of repair) (Lee & Steinberg, 1984). Blumberg (1982) notes that in a field service organization, inventory is typically being recycled as opposed to the "straight through" flow of manufacturing. He states, "Most inventory control systems, originally developed to support manufacturing environments, have failed catastrophically when applied to a field service inventory management system" (p. 7).

Cook, Prather and Testa (1985) found similar problems with service parts management and offer a scheme to analyze and formalize the management of service parts in an organization. The management of service parts must be based on defined market objectives (needs of the customers), formal service objectives (full/partial support of end items, response time), a classification of the inventory

(based on usage characteristics), and an understanding of the parts delivery system. Underlying all of these factors is the basic foundation of selling management on service support. Management must be aware of the importance of service parts management and aware of the contribution to overall company profitability that can be recognized.

Since service parts typically number in the thousands, a means of stratification or classification of inventory is required for effective management. As mentioned, usage levels are suggested (Cook et al., 1985); dollar level and high demand level are also a means to classify inventory (Moody, 1982b). Patton (1984) developed an essentiality rating for service parts management. The rating system attempts to concentrate attention on the most critically important parts. The importance of the item to the performance of the mission is the basis for assigning a rating.

As a means to overcome the problems associated with service parts management, Lee and Steinberg (1984) suggest that firms manage service parts as a product line and exercise centralized control over inventory planning and distribution. This product-line approach gives service parts the same priority as end items. A product-line approach also ensures service parts are properly included in MRP calculations (Cook et al., 1985; Jones, 1986; Schalk, 1981; Testa, 1981).

Cook et al. (1985) point out that many of today's leading firms express a commitment to excellent service. This commitment focuses attention on service parts. As more firms adopt this service commitment to stay competitive, service parts will become a major factor in a company's service support image and will therefore require increased management attention.

Some recent research by Clark (1988), indicates that although the companies are recognizing the importance of spares and including spares in their manufacturing planning, problems still exist:

> The links between production of spares and after sales service would appear to be relatively strong. Companies that use manufacturing planning approaches such as MRPII formally include spares requirements in their schedule, but it is clear from their responses that this is not an easy problem to solve. Problems caused by other manufacturing priorities and the trade off between customer service and inventory cost do not appear to be fully addressed in most companies. (p. 238)

Service parts have not enjoyed the management advances associated with other areas of a business; in fact, service parts have often been ignored. The importance of field service demands a planned approach to the management of service parts underpinned by top management support.

Forecasting

Service parts demand has been described as irregular (Moody, 1982a, 1982b), as having a significant degree of variance and unpredictability (Blumberg, 1982), and as basically random and uncertain (Bleuel & Bender, 1980;

Schloemer, 1983). The forecasting of service parts demand is considered difficult at best (Bram, 1983) and has been described as "the forecaster's supreme challenge" (Moody, 1983, p. 21).

Lee and Steinberg (1984) found that the forecasting of service parts requirements was one of the primary concerns of those engaged in service parts management. If service parts are to be intensely managed and not be treated as the "step-child" of the production process, then an appropriate means of forecasting usage must be developed. In fact, this inability to forecast service parts usage has contributed to the lack of emphasis on service parts--manufacturing or materials management feels the forecast they receive is never realistic so they do not produce or procure items according to forecast. They try to outguess the forecast and produce or procure more or less than forecasted (Lee, 1983).

The problem with service parts forecasts is tied to the relatively high percentage of items that exhibit erratic, irregular, or "lumpy" demand. Lee (1983) reports that some firms have as many as 80% of the line items and as high as 90% of the inventory dollars that experience lumpy demand. Lee and Steinberg (1984) state that traditional averaging or smoothing models do not work well for this erratic demand. To achieve accurate forecasts, inventories must be categorized, and those items with erratic demands must be

recognized and forecasting models for such items must be developed to fit the particular needs of each company.

These forecasting models should contain a number of parameters. For example, resupply lead time--from the time of a reported failure until the item is delivered on-site--must be covered in any forecast of service parts. The number of end items in service in the field at any one time must be known. The system or equipment operating hours and the frequency of component failures based on time in use are indicators of service parts requirements. Other factors that will influence the forecast include engineering changes to increase quality and reliability, marketing promotions, and changes in the distribution system (Lee, 1983; Patton, 1986).

In contrast to Lee and Steinberg, Moody (1982b) and Schloemer (1983) believe the techniques of simple averaging and exponential smoothing can be applied to service parts forecasting. Moody (1982b) further adds that service parts forecasting should be based on good demand history (ideally three years) and requires the use of a planning bill, new product life cycle modeling, and computer power. Great caution is advised and constant review of the forecasts is required. Forecasts should be reviewed monthly to look for changed demand patterns and as required when tracking signals indicate deviations. Smith (1982) and Muir (1983) offer another approach to service parts forecasting: computer simulation. Based on historical data, a number of

forecasting models are tested and the one that was most accurate in the recent past (three months) is selected.

With the increased use of MRP/MRPII, the push for efficiency in manufacturing, and the tight management of inventory levels; unplanned (non-forecasted) service parts demands can create shortages of inventory and disrupt production schedules. A company's ability to develop a service parts forecasting model will allow all demands on the production process to be included in the initial planning stages. Most importantly, when field service is part of the company's business strategy and service parts inventory management is considered critical, the capacity to manufacture these parts must be planned and integrated with end product demand.

Summary

General descriptions of service parts management are provided in books previously mentioned: Bleuel and Bender, 1980; McCafferty, 1980; Berry, 1983; Patton, 1984; Bleuel and Patton, 1986; Patton, 1986. Articles on service parts fall into two general classifications: inventory management and forecasting. Service parts are one aspect of field service that has received some attention in the literature. Perhaps much of the attention has been due to the fact that parts are tangible, measurable items of great significance to the field service organization whether it is organized as a cost center, profit center, or independent business unit.

Although service parts have received some discussion in the literature, this coverage is small when compared to expendable and consumable inventory literature (Lee & Steinberg, 1984). Inventory control systems have been primarily developed for manufacturing environments: a "straight through" flow of parts versus the continual recycling experienced by service parts. Demand for service parts is irregular and influenced by a number of factors that can change rapidly: failure rates, size of installed equipment base, engineering changes, advances in technology. Suggestions for developing forecasting models include the use of computer simulation, using traditional averaging and smoothing techniques, and the rejection of traditional averaging and smoothing techniques in favor of multi-parameter models developed to fit the particular needs of individual companies.

Except for the case studies noted in the introduction to this chapter, spares analysis has focused on components of the system versus the system itself. Inventory management and forecasting techniques have been suggested but their application and implementation have generally not been verified and reported. Lead time reduction, distribution systems, and transportation strategies to reduce inventory levels or raise customer service levels with existing inventory have received little attention. Improved diagnostics to reduce false failures and thereby reduce the inventory required were not addressed. In

general, a systematic analysis of service parts management and the required management coordination with other company functional areas is lacking.

Summary

John C. Shaw is a senior partner of Touche Ross & Company and a visiting professor at The Wharton School of the University of Pennsylvania. Nearly his entire consulting career has centered around service-sector management and his book, The Service Focus, is based on consulting work with hundreds of service-sector clients. Shaw (1990) notes an overwhelming industrial bias in American business. Service managers have a tendency to define themselves in manufacturing terms and to use manufacturing models to manage service organizations. This misapplication of manufacturing experience to the service sector is due to the lack of comprehensive research on service-sector management (p. 24).

Voss et al. (1985) and Johnston (1988) state that the study of operations management has traditionally focused on the management of manufacturing operations--service operations are just now beginning to receive the attention they deserve. The lack of general research in the service sector has been noted by Heskett (1986), Johnston (1988), and, as just mentioned, Shaw (1990). The University of Warwick (UK) has identified the lack of service sector research in a specific area: performance measures. Zeithaml et al. (1990) discovered that literature on service

quality was lacking and quality control principles and practices for quality of goods were inadequate for understanding service quality. Shaw (1990) believes the lack of service quality literature is due to the premium that American management places on the measurable and predictable. "Since tangible products are more readily measured and controlled than intangible services, products command greater attention" (p. 8).

More specific to field service, much of the inventory control literature has paid little attention to service parts (Lee & Steinberg, 1984). Few case studies of field service organizations are available to allow cross-case analysis and comparison of company practices.

Leading corporations and management associations (e.g. IBM, Hewlett-Packard, NCR, the National Association of Service Managers [NASM], the Association For Services Management International [AFSMI]; and the American Management Associations) have identified the need for field service research. At a recent field service seminar, Mr. Arthur Sciarrotta, the Director of Management Consulting Services for Coopers and Lybrand, noted that very little literature is available on specific service management techniques. For field service, what little exists focuses on parts management or field engineer dispatching. Representatives from both AFSMI (Mr. Joseph Tripk) and NASM (Dick Berry) confirmed the lack of field service literature.

From the literature review and conversations with field service practitioners, it is evident that field service is recognized as an important element of a company's business. However, except for a small number of case studies, a few texts on service parts and field service management, and various articles that focus on service parts inventory management and forecasting, no integrative, systematic research exists. Many of these texts and articles suggest the use of traditional forecasting and inventory management techniques instead of examining the field service environment and developing new techniques tailored to that environment.

The lack of field service literature and research requires that the significant questions for the topic of field service be exploratory in nature. Case studies serve as an appropriate research design when exploratory research is required. A detailed discussion of research methodology is provided in Chapter III.

CHAPTER III

RESEARCH METHODOLOGY

Research in Production/Operations Management

Participants at the 1980 American Institute for Decision Sciences Production/Operations Management (P/OM) workshop considered research direction for the "significant and pertinent questions" of P/OM and concluded: "There exists a desperate need for academic fact finding, for extensive systematic field work, and for thoughtful assessment" (Miller & Graham, 1981, p. 564). Practitioner needs must be identified; cooperative research programs between academic researchers and managers in leading-edge companies must be established. The job of academics is to then evaluate and disseminate best practice. This research agenda is not suited to armchair analysis and requires field work with associated research skills in qualitative evaluation (p. 569).

Commentary on Miller and Graham's report was supportive. Buffa (1981) states that a basic change in the mode of P/OM research is required--from a mathematical, analytical orientation to field research. (He also notes that due to the preference and training of past and current researchers, the research agenda may be more suited for the '90s than for the '80s.) Buffa further states that research

will have to start in the field to properly identify the topics worthy of study. Groff and Clark (1981) support the development of empirical, "qualitative" research methodology to supplement traditional quantitative research. They also believe the problems and solutions of P/OM managers of leading companies should be identified and shared. Finally, Hax (1981) calls for exploratory (or diagnostic) studies to identify problems and to determine which of those problems are worthy of "deeper analysis".

This dissertation follows the research direction and emphasis identified in the '80s and of critical importance in the '90s. The research need itself was identified by field service managers of leading electronic firms. Exploratory, field research was required to identify industry practices, to acquire knowledge, and ultimately, to initiate the generation of theory. On-site visits and interviews were required to gather data; written case studies were utilized to present and analyze the findings.

General Research Methodology

A review of research methodology literature provides many dichotomies that describe general research emphasis, orientation, or methodology:

theory building--theory testing
(generation) (verification)

qualitative--quantitative

inductive--deductive

non-experimental--experimental

Miller and Graham's (1981) research agenda calls for research described by the left column. This left column listing also describes the general research methodology used in this dissertation. A description of each dichotomy is presented followed by a summary of this dissertation's research methodology.

<u>Theory Building (Generation)--Theory Testing (Verification)</u>

Glaser and Strauss (1967) provide a description of theory generation in the field of sociology:

> His [the sociologist's] job is not to provide a perfect description of an area, but to develop a theory that accounts for much of the relevant behavior. The sociologist with theoretical generation as his major aim need not know the concrete situation better than the people involved in it (an impossible task anyway). His job and his training are to do what these layman cannot do--generate general categories and their properties for general and specific situations and problems. (p. 30)

Spender (1979) offers this distinction between theory building and theory testing:

> The theory-tester asserts the future tenability of relations which have passed repeatable tests that conform to canons of scientific rigor. The theory-builder, on the other hand, merely creates a new statement and suggests it has factual significance under specific conditions. (p. 400)

Theory building (or generation) begins the process of providing what Miller and Graham (1981) call "usable knowledge, knowledge by which managers can make judgments and decisions" (p. 564). The categorization of relevant events and the identification of specific conditions of significance allows managers to "know the approaches that

are likely to produce the best results in particular types of operations" (p. 567).

Qualitative--Quantitative

Qualitative and quantitative methodology has been the subject of much debate in the social sciences. Glaser and Strauss (1967) support the use of the qualitative methodology and take the position that: ". . . there is no fundamental clash between the purposes and capacities of qualitative and quantitative methods or data" (p. 17). They further state, "We seek . . . to further the systemization of the collection, coding and analysis of qualitative data for the generation of theory. We wish particularly to get library and field research off the defensive in social research, and thereby encourage it" (p. 18).

Bogdan and Biklen (1982) also address the qualitative/quantitative debate and point out conflicting views over "soft" vs. "hard" data, "intuitive" vs. "scientific" approaches, and "journalism" vs. "research." They also state that the tensions between qualitative and quantitative researchers have diminished in recent years and some supporters (e.g. Campbell, Cronbach, Glass) of quantitative methodology have now been advocating the use of qualitative methods.

Inductive--Deductive

Buckley, Buckley and Chiang (1976) make the following distinction between induction and deduction: induction is the process of theory generation; deduction, theory testing.

Inductive research is fact finding. Spender (1979) points out that Kaplan argued for two kinds of explanation or theory, "deductive," which is logical, and "pattern," which is inductive. A deductive theory is logically true; it follows by deduction from other established theory. A pattern theory is dependent on a pattern of experience; it is an empirical generalization induced from past instances.

Babbie (1973) and Clover and Balsley (1984) state that the inductive method starts with observed data and develops conclusions or generalizations that explain relationships between objects observed and that can serve as principles in future research. Clover and Balsley (1984) additionally state, "It would seem apparent, then, that inductive reasoning is the process followed when new facts are being studied, new truths are being uncovered, and new generalizations are being formulated on the basis of information forthcoming from a research project" (p. 19).

Non-experimental--Experimental

Commenting on research design, Merriam (1988) explains that the most basic distinction in design is between experimental and non-experimental. The major intent of experimental research is the investigation of cause-and-effect relationships. Non-experimental, or descriptive research, seeks an explanation or description; its aim is to examine events or phenomena.

Summary

As pointed out in Chapters I and II, the area of field service is a new frontier. Very little has been published and few case studies exist. The research effort was directed at theory building using inductive, non-experimental methods and primarily qualitative data.

Case Study Research Design

Guidelines for Use

Merriam (1988) defines research as systematic inquiry. She states that there are numerous well tested designs and techniques to help guide the inquiry and suggests that the case study is one such research design that can be used to study a phenomenon systematically. In her discussion of the *role of the case* study, Merriam (1988) points out, "It [case study] offers insights and illuminates meanings that expand its readers' experiences. These insights can be construed as tentative hypotheses that help structure future research; hence, case study plays an important role in advancing a field's knowledge base" (p. 32).

Yin (1989) offers guidelines for the use of case studies based on three conditions: (a) the form of the research question: who, what, where, how many, how much, why; (b) the requirement of control over behavioral events; and (c) the focus on contemporary as opposed to historical events. A case study has a distinct advantage when "how" or "why" questions are being asked about contemporary events over which the investigator has little or no control. (In

contrast, an experiment is used when the direct and precise manipulation of behavior is required; a history addresses past versus contemporary events.) "What" questions for exploratory studies also lend themselves to use of the case study.

A unique strength of the case study is the ability to use multiple sources of information--documentation, interviews, direct observation and archival facts. Eisenhardt (1989) points out that theory-building researchers typically use multiple data collection methods and sources. She further states that the case study method is "particularly well-suited to new research" and is "most appropriate in the early stages of research on a topic" (p. 548).

Validity and Reliability

Case studies and qualitative research have traditionally been criticized as lacking validity and reliability. Glaser and Strauss (1967), Merriam (1988), Eisenhardt (1989), and Yin (1989) offer various case study tactics to ensure reliability and validity. Those tactics applicable to exploratory, theory building research are listed below.

Internal Validity

1. Use multiple sources of data and multiple methods of investigation to confirm emerging findings. This practice is known as triangulation.

2. Perform member checks--have the subjects who were interviewed review the data and interpretations.

3. Utilize peer examination--ask colleagues to comment on the findings.

External Validity

1. Use replication; perform multiple case studies. This enhances the extent to which the research findings can be generalized to other situations.

2. Perform cross-case analysis. This analysis allows the search for generalized categories and patterns. Glaser and Strauss (1967) discuss this process in the area of sociology:

> The constant comparing of many groups draws the sociologist's attention to their many similarities and differences. Considering these leads him to generate abstract categories and their properties, which, since they emerge from the data, will clearly be important to a theory explaining the kind of behavior under observation. Higher level, overriding and integrating conceptualizations . . . come later during the joint collection, coding, and analysis of the data. (p. 36)

Reliability

Create a case study data base--a formal, retrievable data base, independent of any reports by the original researcher, that can be reviewed and analyzed directly by other investigators. Yin (1989) states that the data base "will increase markedly the reliability of the entire case study" (p. 99).

Sample Selection and Size

The type of non-random sampling logic advocated for exploratory, case study research is purposive sampling.

Merriam (1988) explains that purposive sampling is "based on the assumption that one wants to discover, understand, gain insight; therefore one needs to select a sample from which one can learn the most" (p. 48). She provides this quotation from Chein as an illustration:

> The situation is analogous to one in which a number of expert consultants are called in on a difficult medical case. These consultants--also a purposive sample--are not called in to give an average opinion that would correspond to the average opinion of the entire medical profession. They are called in precisely because of their special experience and competence. Or the situation may be viewed as analogous to our more or less haphazard sampling of foods from a famous cuisine. We are sampling, not to estimate some population value, but to get some idea of the variety of elements available in this population. (p. 48)

Concerning the sample size, Eisenhardt (1989) suggests that while there is no ideal number of cases, between 4 and 10 cases usually works well. Empirical grounding and theory complexity are lacking with fewer than 4 cases; data complexity and volume can overwhelm the researcher when more than 10 cases are undertaken.

Case Analysis

Two types of case analysis can be performed: single-case (within-case) analysis and cross-case analysis (Yin, 1989). Eisenhardt (1989) points out that within-case analysis enables the researcher to become intimately familiar with each individual case and also allows the patterns of each case to emerge. Cross-case analysis, which implies two or more cases, seeks to build abstractions across cases (Merriam, 1988). Processes and outcomes from

individual cases are compared and patterns (or lack of patterns) noted.

Operationalizing the Case Study Research Design

Focus of Research

Although the problems associated with the field service function are not limited to any one sector of business, the electronics industry was the focus of this research. The electronics industry is an area where service-based competition is increasing and where this competition can play a major role in company profitability and survival. Additionally, the electronics field service market is rapidly growing and the electronics products service industry is among the leading service sectors in the U.S. economy.

Research Questions

Research questions for this study are based on the field service system framework suggested by Voss, Armistead, Johnston, and Morris (1985). The questions are stated here:

1. How is the field service function organized?

2. What is the field service strategy and how does that strategy contribute to the overall company strategy?

3. What performance standards and measures have been set to evaluate field service performance?

4. What service processes make up field service operations?

5. How is the management information system organized within the field service organization and what information interfaces exist with other company functions?

6. What logistical techniques are used to manage service parts?

These six questions served as the basis for the development of specific interview questions.

Selection of Companies

The in-depth, exploratory nature of the research required a small sample size. Purposive sampling was used to select leading field service companies based on the research objective of discovering, evaluating, and disseminating "best practice." Leading companies were identified based on listings compiled by Fortune magazine ("Fortune 500," 1989), by the Ledgeway Group's "Top 100+ Service Providers" (Vancil & Phillips, 1989), and through telephone conversations with field service consultants, representatives of professional associations, and practitioners. It was assumed that service revenue is a measurement of field service leadership and that these leading companies have a field service organization that provides the service function. Experts in the area of field service were also utilized to assist in company selection based on their knowledge of the electronics field service industry.

Nine companies were sent a pre-visit questionnaire [Appendix A] primarily designed to determine interest in

participation and secondarily to gather some preliminary, general information. Six companies responded and five of the six indicated a willingness to participate in the study. Companies that failed to reply were contacted by telephone. A lack of time and/or company reorganization were cited as the reasons for not desiring to participate. Two of the five who originally agreed to participate subsequently declined: one due to a recently initiated company reorganization; the other cited concerns with compromising confidential competitive practices.

Three additional companies were contacted based on referrals from various industry sources. These three brought the number of participating companies to six. A point of contact was requested and designated by each company.

Pilot Study

Yin (1989) proposes conducting a pilot case study to prepare for data collection. The pilot case serves to provide greater familiarity with the research topic, to refine data collection procedures for case study research, and to develop relevant lines of questions. Additionally, questionnaires can be tested and checked for question clarity. Accessibility and geographical convenience are two recommended criteria for selection. NCR Corporation located in Peachtree City, Georgia was selected as the pilot or test case company. Lessons learned from the test case were used to modify and improve the data collection plan.

Due to the small number of available participants and the high service ranking of NCR (number 5 in service revenue as ranked by the Ledgeway Group), the pilot study will be included in the case studies.

Data Collection

Data collection consisted of the previously mentioned questionnaire and on-site observation and interviewing. Each company was sent a copy of the dissertation prospectus along with a listing of the major research areas. Interviews were guided by the questions in Appendix B and the answers were recorded and included in the field (on-site) notes. Where permitted, each interview was also audio tape recorded. Since the research was exploratory, questions were primarily open-ended. Company documentation pertaining to the field service function and service parts management was reviewed and copies obtained, if permitted. The questionnaire responses, field notes, audio tapes, and company documentation comprise the case study data base. This data base serves to increase the reliability of the case study (Yin, 1989). Additionally, triangulation, accomplished by using multiple sources of data and multiple methods of investigation, enhances the internal validity of the research.

Data Processing and Analysis

Data collected from each company was prepared as a separate case study. Both within- and cross-case analysis were performed to identify generalized patterns and

categories for each case and across cases. Within-case analysis consisted of the preparation of detailed, descriptive case study write-ups. The field service system components (organization, strategy, performance measures, operations, management information systems, and parts management) were used to organize and present the narrative data. Organizational charts and service blueprints (flow charts) are included in each case study to provide a method of visual analysis and to facilitate identification of the service flow and the interrelationships of service elements. Within-case analysis allowed the unique patterns of each case to be identified.

After each individual case was analyzed, cross-case analysis was used to compare cases and to search for patterns--similarities as well as differences were observed. Multiple case studies and cross-case analysis enhance the generalizability of the research findings and serve as tactics to ensure external validity of the findings. From this analysis (within- and cross-case), field service management propositions and a field service system model were developed.

Individuals interviewed were provided copies of their particular case report and given the opportunity to review and make any necessary corrections. These member checks by the case study subjects and the review of the dissertation by dissertation committee members and colleagues contributed to the internal validity of the research project.

Summary of the Research Process

Figure III-1 provides an overview of the dissertation research process. It is adapted from Schendel and Hofer's (1979) general research paradigm (pp. 388-389) and Clover and Balsley's (1984) description of the scientific method (p. 36).

Topic selection was based on personal interest and the increasing awareness that field service is an important competitive edge for many businesses and of critical importance in the electronics industry. The literature review (Chapter II) revealed little published information on the topic of field service and service parts management. A system's perspective was found to be lacking in what literature was available. Telephone conversations with industry consultants, field service practitioners, and personnel at national field service professional associations confirmed the findings of the literature review. This lack of data suggested a general research methodology classified as: inductive, non-experimental, qualitative, and theory building. Exploratory, open-ended research questions were developed to provide comprehensive, in-depth information.

The case study research design was determined to be the best suited for the general research methodology. Leading companies were identified and purposive sampling was used to select the actual participants. A pilot study was performed to check and refine the data collection process.

TOPIC SELECTION
Field Service System
Electronics Industry

LITERATURE REVIEW
General Research Methodology
Research Questions

RESEARCH DESIGN SELECTION
Case Study

SAMPLE SELECTION
Purposive Sampling
Leading firms

DATA COLLECTION
Literature Review
Pre-visit Questionnaire
Pilot Study
On-site Observation
On-site Interview

DATA PROCESSING
Case Study Report

DATA ANALYSIS
With-in/Cross-case Analysis

CONCLUSIONS/INTERPRETATIONS
Model/Propositions

Figure III-1. Steps in the Research Process.

Questionnaires, interviews, and on-site observation were used to collect and supplement data from the literature review. Six case study reports were then compiled and within- and cross-case analysis used to produce field service management propositions and to develop a field service system model.

CHAPTER IV

CASE STUDIES

Introduction

Following each company visit, a case study documenting the findings was written. The six case studies are presented in the following order: National Cash Register (NCR), International Business Machines (IBM), Amdahl Corporation, Hewlett-Packard Company, General Electric Computer Service, and American Telephone and Telegraph Computer Systems.

National Cash Register

Overview

National Cash Register (NCR) is a multinational corporation which develops, manufactures, markets, installs, and services business information processing systems. The company offers one of the broadest hardware and software product lines in the industry. Computers range from personal computers to small business systems to general purpose processors. NCR computers are supported by a broad range of terminals, office automation products, peripherals, data communication networks, and an extensive library of software products. Supplemental services and products include field engineering, disaster back-up and recovery

assistance programs, semiconductor components, educational centers, data systems, and systems engineering.

NCR has sales in excess of $5 billion and employs over 60,000 people worldwide. Products and services are marketed in more than 120 countries out of more than 1000 offices. Worldwide markets are primarily in the retail, financial, commercial, industrial, health care, education, and government sectors. The worldwide organization includes 2 microelectronics facilities, a worldwide service parts center, 5 systems engineering plants, 16 manufacturing plants, and 9 Systemedia (NCR's system media support) facilities that provide business forms, media, and supplies. Corporate offices are located in Dayton, Ohio.

Organization

NCR is organized into two major functional areas--Marketing and Manufacturing. Field service falls under the Marketing area and the Customer Services Division (CSD) is tasked with developing, marketing, and providing services and service-related products for U.S. markets.

The field service organization consists of 6 geographically based divisions. The six geographic divisions with their respective headquarters are: Southeast, Atlanta; Mideast, Dayton; Northeast, New York City; North, Chicago; Southwest, Dallas; and West, Los Angeles. Within the six geographic divisions are approximately 5,000 field engineers (FEs) in over 400 locations. (The division organization as well as the CSD

organization is portrayed in Figure IV-1.) The field organization consists of field engineer group leaders, zone managers, district managers, region directors, and area vice presidents. There are 6 area vice presidents assigned to each division; unlike the other organizational units, these area assignments are not geographical but instead are referred to as "vocational." In other words, there is an area vice president for financial affairs; one for administration; and vice presidents for retail/commercial-industrial/or designated special markets. Included is an Area Vice President for CSD who serves as the top of the field service reporting pyramid and who in turn reports to the Division Vice President. (The service parts management network and the parts management organization are discussed later in this case.)

The current geographic divisions are a result of a company reorganization in 1990. The goal of the reorganization was to provide greater decentralization of decision making by moving sales and support management closer to the customer. In line with this goal, each division operates as an autonomous business unit with dedicated sales and support staffs. Division vice presidents report to the Vice President and Group Executive of the United States Marketing Group.

The Vice President of the Customer Services Division (CSD) also reports to the U.S. Marketing Group Vice President and Group Executive. CSD provides support,

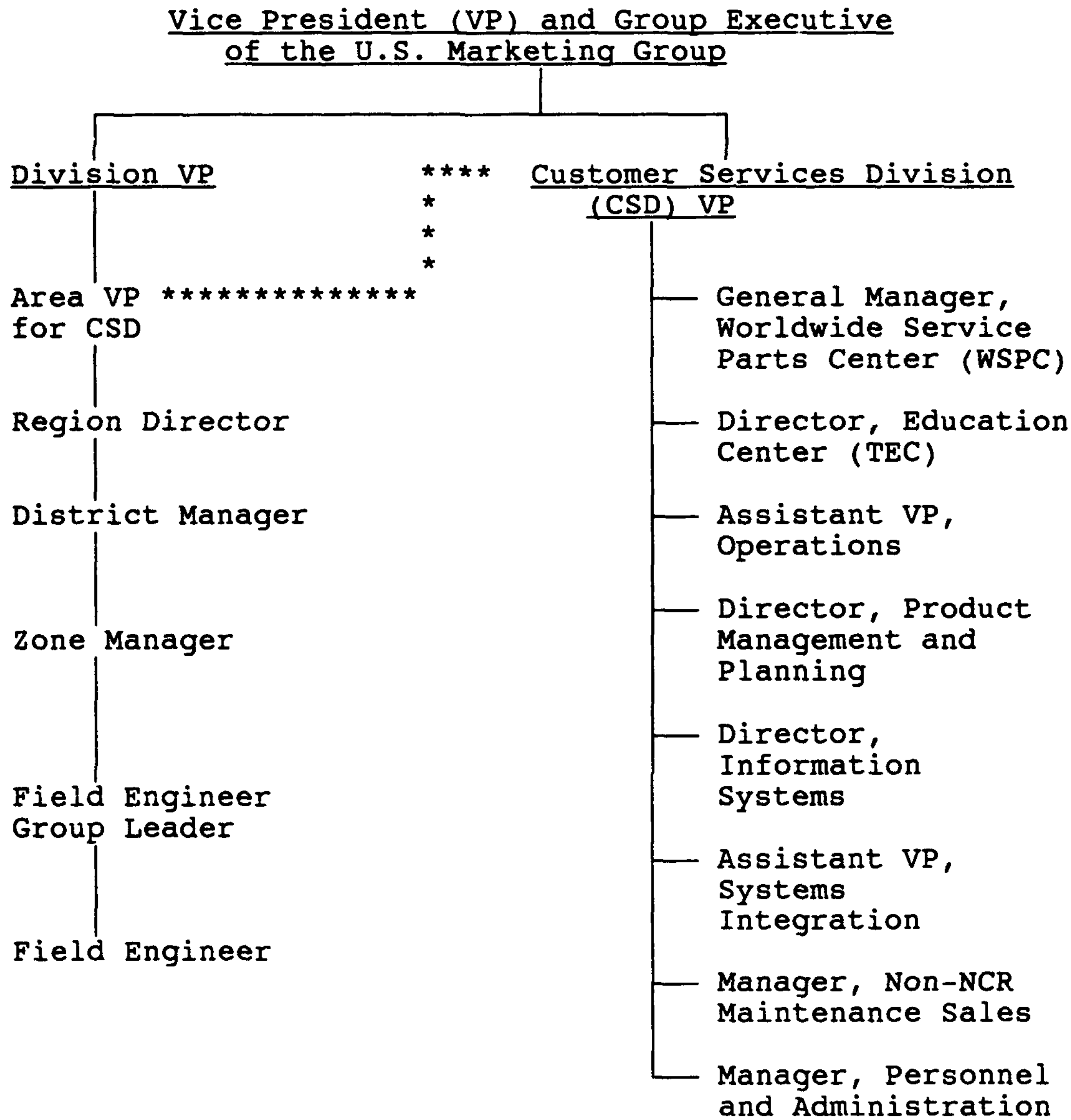


Figure IV-1. NCR Field Service Organization.

direction, and programs for the dispersed field service organization and personnel from its Dayton location. Field service personnel assigned to the various divisions have a "dotted" reporting line to CSD.

Reporting to the CSD Vice President are the General Manager of NCR's Worldwide Service Parts Center, the Director of the Technical Education Center, the Assistant Vice President of Operations, the Director of Product Management and Planning, the Director of Information Systems, the Assistant Vice President of Systems Integration, the Manager of Non-NCR Maintenance Sales, and the Manager of Personnel and Administration. The primary functions of each of these home-office, staff positions will be briefly discussed.

The General Manager of the Worldwide Service Parts Center (WSPC) is tasked with centralized service parts management and with the overall coordination of parts distribution for CSD. The WSPC is located in Peachtree City, Georgia, just south of Atlanta. Located in Miamisburg, Ohio, the Technical Education Center (TEC) provides both initial and continuing training for field engineers. The TEC director manages instructors, curriculum development, and physical assets consisting of dormitories, classrooms, and a dining hall. The Assistant Vice President of Operations is tasked with the daily monitoring of field service operations and management of the dispatch and Level 2 (problem assistance to FEs) functions. New releases of

maintenance options and packages are the responsibility of the Director of Product Management and Planning.

The Director of Information Systems serves as the information systems manager for all internal CSD systems. Systems integration provides compatibility and interoperability among NCR's and other vendors' products and services. This is a rapidly growing area and the Assistant Vice President of Systems Integration is tasked with developing programs, policies, and pricing for NCR systems integration services. The Manager of Non-NCR Maintenance Sales is concerned with maintenance of non-NCR manufactured items, or NCR's third party maintenance offerings. The final member of the CSD staff, the Manager of Personnel and Administration, provides centralized management of administrative policies and maintains personnel locator files, job descriptions, and salary information.

Strategy

Service Goal/Competitive Differentiators

NCR's Customer Services Division (CSD) has a very simply stated goal--to provide the highest level of customer support in the industry. Four factors are considered important contributors to this goal: service experience, parts distribution, field engineer training, and nationwide coverage. NCR has been in the service business since the 1880s, when the company was founded. As products have evolved from mechanical cash registers to sophisticated electronic computer systems, customer service practices have

been developed and refined. Few, if any, electronics companies can claim service experience of this length. Parts distribution is facilitated by an on-line parts system that can be accessed by local parts clerks (co-located at field service offices), allowing the locating of parts nationwide. If a part is not available in the local area, an order is placed with the Worldwide Service Parts Center. The location of the centralized parts distribution center at Peachtree City was chosen primarily for its transportation access--parts can be air shipped overnight, or sooner if maintenance contract conditions warrant, to field engineers at any U.S. location.

Applicants for field engineer positions must have a two-year technical college degree or its equivalent in training and experience. To provide initial training for field engineers and to provide continuing education as new products are released, NCR operates a Technical Education Center in Miamisburg, Ohio. The center can house 600 students, has 120 classrooms, 68 instructors, and 40 curriculum developers. In addition to traditional instructor/lecture programs, interactive video disks, satellite broadcasts, and self-paced learning centers are utilized.

Finally, NCR believes they can provide service coverage that no one else can offer. In addition to coverage in major metropolitan areas, cities, and towns with high product concentrations; NCR offers coverage of "remote"

(or low product concentration) areas through resident personnel. The resident field engineer lives in and services the locality around him. For example, Atlanta 1 (there are two district offices in Atlanta) functions as a District Office with Zone Offices in Rome, Columbus, Macon, and Athens. A resident field engineer lives in Toccoa (a low product density area) and services the area around Toccoa, receiving parts and administrative support from the Athens Zone Office. Faster response to customer needs is achieved through this organizational approach.

Corporate Strategy/Field Service Strategy

Most organizations' information systems were not purchased and installed at one time. Instead they have evolved and grown with the organization and often consist of products from various manufacturers. Customers now demand that computers from different manufacturers work together and they demand a single source supplier of service.

To respond to these changing customer requirements, NCR formulated a long-term product direction known as Open, Cooperative Computing (OCC). This product strategy allows customers to incorporate rapid technological change while protecting past investments in information systems. The Open, Cooperative Computing strategy is based on three elements: open systems, cooperative computing, and an end-user focus. An open system is a set of standard relationships that enable different computers, subsystems, and software to operate together. Cooperative computing

refers to the networking of computing functions throughout a business. Also included in this concept are network configurations that allow system modules to be added or deleted, keeping user options open for future network growth, expansion, and upgrading. Finally, end-user features make systems easy to learn, use, and manage.

Open, Cooperative Computing is supported by the third party service role of CSD. Until 5 years ago, NCR serviced only their own products; now the company has initiated third party servicing. All hardware and software systems that NCR develops, produces, and sells in the 1990s will be of an open architecture configuration. Industry standards will be followed to allow any company's system/components to be used in a network with NCR products. Recent hardware and software releases (September/October, 1990) facilitate networking of existing systems. CSD will have the ability to network systems, with equipment from many manufacturers, while providing a single source supplier for service. To be a service leader in the 1990s, NCR is prepared to service almost any product on the market.

CSD desires to provide the best possible service and offers service options that range from full, on-site maintenance provided by NCR to self maintenance by the customer. All service offerings can be tailored to fit each customer's individual needs. For NCR-supplied maintenance, a company-wide response time (from customer problem report to FE arrival at customer site) of 4 hours is the service

goal. To reduce costs, customers may tailor maintenance packages. Tailoring of services may involve the reduction of contracted hours of coverage or a willingness to accept a longer service response time (e.g. next-day response versus the 4-hour goal). Customers may also desire to perform some maintenance tasks themselves and have NCR perform other functions.

Dealer Networks

In addition to the CSD service organization, service is provided through dealer networks. These dealer networks sell primarily NCR PCs and PC related products; Arrow Electronics and Businessland are two examples. CSD offers a program called PROTEC to these dealers which provides three service options:

1. The dealer installs the system but turns the customer over to NCR for service.

2. The end-user remains the dealer's customer but NCR provides the service and bills the dealer. With this option, the dealer is in effect contracting with NCR for service while maintaining a close customer interface.

3. The dealer performs his own service work. If this option is chosen, the dealer can purchase training and parts from NCR. Service technicians will receive the same training as CSD field engineers in NCR schools.

Additional flexibility is also offered with option three. A dealer can perform service within a geographical area or on a specific product (or products) and contract

with NCR to handle customer service outside the geographical area or to service additional product line offerings. For example, a dealer in Athens, Georgia, may sell to customers in Athens as well as to customers near Atlanta. The Athens dealer could confine his service to the Athens area only and contract with NCR to perform service for all customers outside of the Athens area.

Product Serviceability/Parts Support/Product Development

CSD and manufacturing teams work closely to provide products that meet customer requirements (as determined by marketing research) and that are supportable by the field service organization. Figure IV-2 outlines the CSD/Manufacturing interface which is discussed in this section.

To insure NCR products are easy to service, CSD personnel are actively involved early in the development of new products. A team of CSD field engineers is assigned to every manufacturing facility. These field engineers work with the design engineers to insure that serviceability is considered in the early development of products. Product size and aesthetics must be balanced with the ability to provide service. Prototype units are built and then evaluated by service personnel.

Due to changing technology, a life cycle of eight years is used for planning product support. For new product introductions, manufacturing and CSD teams work closely to develop a recommended spares list based on evaluation of the

Field Engineering Maintainability/Supportability Teams

Manufacturing/Engineering Plant Teams

—>Serviceability/Size, Aesthetics Tradeoffs

—>Recommended Spares List For New Products

—>Analysis Of Parts Usage/Service Activity Levels

Engineering Change Orders

Revision Of Spares List

—>In-Plant Testing And Evaluation Of Products

Engineering Change Orders

—>End Of Support Provisions

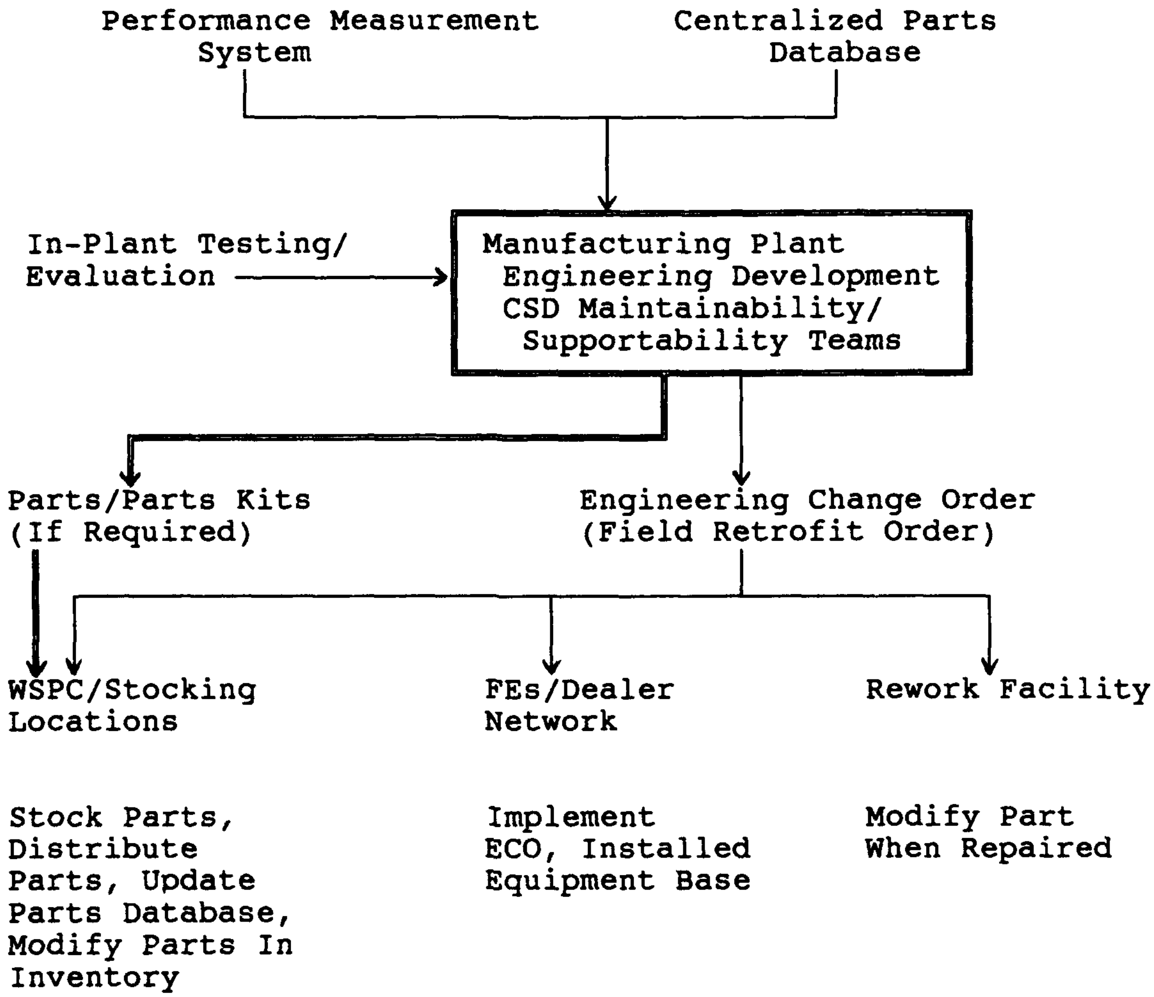
Figure IV-2. CSD/Manufacturing Interface.

unit prototype, projected engineering failure data, and historical failure data of similar products or components. The parts on the recommended spares list are monitored very closely during the first year of service utilizing the centralized parts database maintained by the WSPC. Reports on parts usage are received weekly, monthly, and on demand. Changes to the recommended spares are made based on utilization records. Additionally, the spares pattern of use is monitored over a three to five year time frame and adjustments are made as required.

Once the product is in the field, two databases are used to plan and monitor product modification: the centralized parts database and the Performance Measurement System. The centralized parts database is an on-line, computerized database used to monitor inventory status and parts usage. The centralized parts database is used not only to modify the recommended spares lists but also to detect unusual failure rates of parts. Unusual failure rates are analyzed to determine if a need for an equipment modification is required. Service activity (e.g. problem descriptions, machine types, customer), reported by field engineers through the Performance Measurement System, is also monitored by the manufacturing plant teams. Reports are received with the same frequency as parts usage (monthly, weekly, and on demand) and are also analyzed to detect high and unexpected service activity.

Part failure rate analysis, service activity analysis, and in-plant testing/evaluation are utilized to detect problems and improve product performance. These improvements take the form of engineering change orders (ECOs) and are communicated to the field in the form of field retrofit order documents. Figure IV-3 traces the Engineering Change Order (ECO) or modification process. ECOs can apply both to part and procedure changes/ modifications. There are three basic types of ECOs: safety, mandatory, and designated unit mandatory. For safety ECOs, which are relatively rare, immediate replacement of a part, modification of equipment, or change of procedure is required. Mandatory ECOs require modification or change for all equipment using a particular part or procedure. Designated unit mandatory ECOs require change or modification on only those units exhibiting a particular problem.

Depending on the criticality (safety or system performance) of the ECO, parts may be modified immediately by the manufacturing plant and provided to the WSPC for distribution, existing stock may be used until depleted, or parts may be modified when next repaired (either by the FE or if a reworkable part, when the part cycles through the repair facility). Criticality also determines how parts required for ECOs are distributed. Critical parts or parts kits are pushed to the WSPC for distribution to districts/dealers. Machines are tracked by customer,



<u>Figure IV-3</u>. Engineering Change Orders.

geographic location, and maintenance server; ECOs are shipped by the WSPC to the appropriate district/dealer based on machine population in the geographical location. Less critical modifications are described in ECO bulletins sent to the field engineering organization stating availability and the need to request parts or kits as required.

At the end of a product's life cycle, no more orders are taken and end-of-support provisions are made. Normally products are on the market for five to eight years; however, if a product's sales decrease, it may be dropped from the product line sooner. When a product is dropped, CSD's general policy is to continue procuring parts from the manufacturing plants to allow support for an additional eight years. If a part will no longer be available due to a change in manufacturing processes or industry standards, a final buy will be made. If a final buy of parts is required, the quantity of parts ordered and stocked is based on historical usage and product population. Final-buy parts are generally centrally stocked at the WSPC.

Repair Strategy

Changing technology has affected the repair process of the field engineer. Years ago, with transistor/resistor technology, problems could be traced with an oscilloscope and most components could be repaired in the field. Today, with the technological advancements in mounting and layering of components on circuit boards, better repair results can be obtained by swapping boards and returning the defective

board to the repair center. Numerous components are contained on one board making it difficult to repair at the component level in the field.

Remote diagnostics allow the monitoring of computer (or any electronics) system performance from a central location. Fault reporting is provided by sensors built into the equipment and fault analysis can be performed at a location remote from the actual equipment. Telephone lines are generally used to link the monitored equipment to the remote fault analysis site. NCR has remote diagnostics capability and maintains a remote diagnostics center; however remote diagnostics were used more in the past than they are now. Much of the new equipment has built in diagnostics that the customer can run before reporting the problem or the field engineer can run upon arrival.

Performance Measures

As previously mentioned, each of the 6 Divisions operates as an autonomous business unit with dedicated marketing/sales and service organizations. The service organization functions as an autonomous profit center below the division level. Service doesn't share in marketing revenues/profits and marketing doesn't share in service revenues/profits. All revenues are ultimately combined in the division level profit and loss statement.

The division field service organization operates as a profit center and is expected to generate revenues and profits. Revenue for field service is a function of the

maintenance options purchased; in other words, service revenue is generated by the number of machines in use and their associated service contracts. Marketing and sales primarily drive the opportunities for field service revenue; FEs do little direct selling.

Costs are managed by field service managers with primary emphasis on controlling overtime and parts/inventory costs. Overtime costs are considered to be subject to management control. Overtime is closely analyzed to determine cause; when the cause is identified, it is the manager's job to eliminate or reduce the need. Stock levels (and associated costs) of parts at the district, zone, and field engineer levels are controlled by the CSD District Manager. Salary and travel costs are driven by the number of FEs required to maintain the installed equipment base and the geographic dispersion of the base. Both salary and travel costs are considered fixed.

In addition to the traditional revenue and cost measurement, CSD rates its own performance using a customer report card. This card is generated by CSD and sent to the customer. It is designed to report how CSD has served the customer. Data is extracted from the corporation's Performance Measurement System, a centralized database covering field engineer and equipment performance. The database is constantly updated with service information supplied by field engineers utilizing hand-held terminals and telephone links. The Performance Measurement System

allows NCR to monitor equipment activity, evaluate product performance, and determine the level of field engineer performance needed to support an installed base of equipment. Information such as response time (time call was received to time FE arrived on site), equipment down time, number of calls (made by the customer), number of repeat calls (call backs by customer to correct the same equipment problem), and average repair time (duration of call) are included on the customer report card.

Quarterly over 25,000 customers (approximately 25% of the customer base) are surveyed by mail to assess customer satisfaction. Approximately fifty percent of the mail questionnaires are returned. Questions cover a range of issues: professionalism, competence, and courtesy of the field engineer; quality of parts and products; ease of contact when requesting service; availability of off-hour maintenance; and satisfaction with preventive maintenance programs and system installations. Customer ratings are compiled by the corporate headquarters and feedback is supplied to the divisions for distribution to lower levels of management and FEs.

If customers are dissatisfied with service and wish to register a complaint, they are encouraged to work with the zone or district representatives to resolve the problem. However, customers receive correspondence that provides a corporate phone number if they believe the complaint should be elevated. The president of NCR has a staff that

specifically handles customer complaints. If a complaint reaches this level, a formalized procedure is implemented. The organization the complaint was filed against must report to the corporate staff concerning the status of the problem and what measures were taken to resolve the problem. The customer then receives a formal reply from the corporate executive office stating how the complaint will be resolved.

Information Flow

Intra-Division Information Exchange

As previously mentioned, CSD interfaces with manufacturing through field engineering teams assigned to each manufacturing plant. Field service and marketing personnel are co-located down to the district level which facilitates daily information exchange. Formal, scheduled meetings are also held no less than once a month. These meetings are held at the area locations and are attended by district field service managers, district marketing personnel, and representatives of the Administrative section, an in-house support agency. The meetings provide a formal means of sharing general information, presenting sales orders for the month (and impact on service support), discussing new product offerings and releases, determining ways to assist one another, and adjusting strategy based on changing market conditions.

Management Information System (MIS)/Service Operations

The field service MIS consists of three systems, portrayed by Figure IV-4. The installation of new

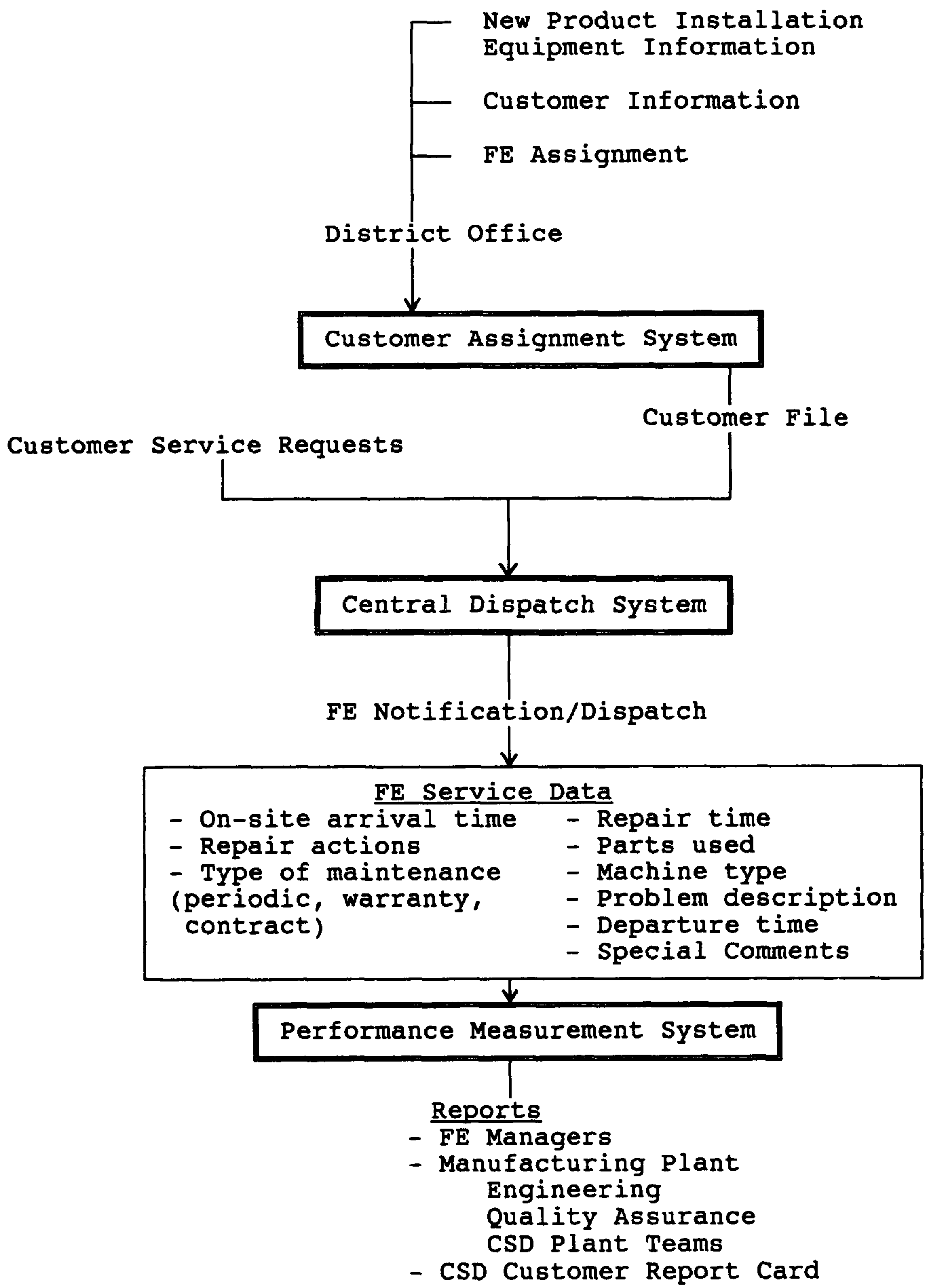


Figure IV-4. Major Field Service Information Systems.

equipment, specific data on the equipment (type, serial number, location), customer information (name, address, type of service contract, phone number), and Field Engineer assignment are entered into the Customer Assignment System by District CSD personnel. This data is formatted into the customer file.

Central Dispatch is the system which dispatches field engineers for service. Five Service Coordination Centers are located in the United States and are accessed by a central toll-free number. The five locations, Atlanta, Dayton, Chicago, Dallas, and Tacoma, are redundant and geographically dispersed for survivability. Which one of the five a customer reaches is based on the center's workload; if all Atlanta lines are busy, calls will be automatically directed to another center.

When a request for service is received, it is assigned to the appropriate FE's call list using the Customer Assignment System. The Customer Assignment System allows keying to a customer's file using the customer's phone number or NCR customer number. Central Dispatch personnel also receive a problem description from the customer and pass this along to the FE.

The third system, the Performance Measurement System, is constantly updated by Field Engineers and provides a centralized database of field service activities. This database can be accessed by any corporate organization requiring the data and granted the proper access. As

previously mentioned, this system is the source of information for the Customer Report Card and for new products, Manufacturing is provided reports automatically on repair data.

Field service operations are presented in Figure IV-5. When a customer requires service and places a toll-free call to the Central Dispatch function, dispatch personnel request the customer's telephone number (or NCR customer number), equipment identification information, and a description of the problem. The customer file is pulled from the Customer Assignment System using the customer's phone number or NCR customer number. The assigned FE is determined, notified, and provided a description of the problem via telephone links to a hand-held terminal.

At the beginning of each day, the FE downloads his list of calls from the system to his hand-held terminal via a telephone link, selects one, and notifies the system of his choice. Selection of which call to service first is based on the service package purchased by the customer and/or the criticality of the down equipment. A customer whose contract states no more than four hours of equipment downtime receives priority over a customer who has contracted for next day service. Similarly, a customer with one printer out of four down receives less priority than a customer whose only printer is inoperable. When the service call is complete, the FE enters repair data into the hand-held terminal and passes repair status to the corporate

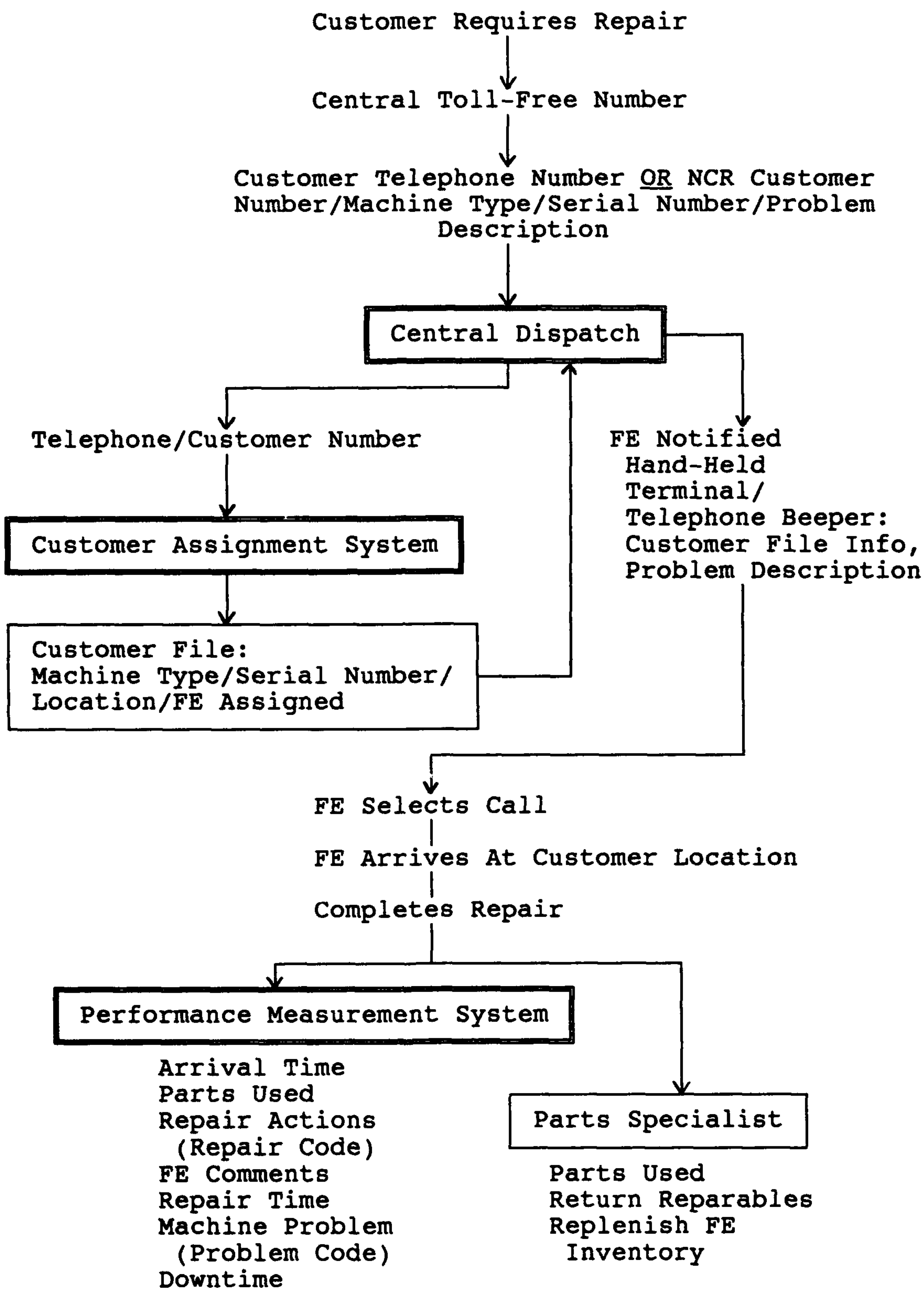


Figure IV-5. NCR Service Operations.

centralized database, the Performance Measurement System. The Performance Measurement System includes status on NCR-supplied service only; data on service supplied by dealers is not tracked. Information on parts usage is also supplied to the parts specialist at the servicing parts room.

If the call is an emergency (rapid response dictated by the customer's contract or conditions), the FE is notified by telephone pager. If the FE cannot respond immediately or within the specified contract response time, backup FEs can be contacted to handle the call. A pager is also used to notify of any new calls added to the call list. Currently an RF (radio) system is in the process of being implemented that will eliminate the need for telephone access and pagers. Radio signals will be used to link the hand-held terminals with the Centralized Dispatch System, the Performance Management System, and the centralized parts database (Field Engineering Inventory Management System).

If the FE encounters difficulty in solving the customer's problem, two problem escalation levels are available. Group Leaders, FEs with advanced technical expertise, are available for telephone consultation and on-site assistance. Level 2 support provides assistance from maintenance specialists who run remote diagnostics (if the equipment is so configured) and suggest maintenance actions. Level 2 personnel also suggest tests and checks to be performed by the on-site FE and may request additional support from manufacturing and engineering representatives.

Service Parts Management Network

The Worldwide Service Parts Center (WSPC) has over 300,000 square feet of warehouse space and employs over 600 people in nine functional areas: Finance, Information Systems and Services, Quality Assurance, Personnel Resources, Operations, Customer Service, International Distribution, Repair Development, and Inventory Management and Control. The WSPC serves as a centralized service parts management and distribution operation; a centralized management approach was chosen to facilitate automation and total asset management. The Center provides 24 hours per day/7 days per week parts service. The WSPC provides parts to field stocking locations throughout the United States as well as to international distribution centers in Schiphol, Holland, and Hong Kong. Additionally, service parts are warehoused at Service Parts Distribution Centers (SPDCs) located near manufacturing plants in Osio, Japan; Dundee, Scotland; and Augsburg, Germany. These SPDCs warehouse only the service parts produced by the plant they are associated with; they also supply their service parts to the WSPC for distribution.

Forecasting/Order Management

Item managers assigned to the Inventory Management and Control function at the WSPC create forecasts for parts families using 24 months of historical data. Rapidly changing technology generates numerous engineering changes and parts revisions which require the forecasting of spare

parts requirements for a family of items rather than for individual items. A parts family consists of all parts that are upgradeable or interchangeable with the prime part number. These factors, upgradeability and interchangeability, as well as the demand for parts and the return of parts for repair are used to create forecasts. Exponential smoothing, double exponential smoothing, and moving average are used. Seasonality, which affects some parts families, is managed on an item-by-item basis by the inventory managers. Forecasts for new item spares are provided by maintainability and supportability specialists (members of the field engineer team) located at the plant which produces the new product. Maintainability specialists base their forecasts on factors such as the number of units in service, mean time between failures, and historical demand patterns for similar parts. Forecasts for other company products' spares (third party spares) are provided by a corporate technical group located in Dayton. This group analyzes other companies' products' failure rates and marketing plans. Based on this analysis of projected equipment base and failures, a recommended spares list is provided.

It is also the item manager's job to initiate an order to buy parts. An economic order quantity (EOQ) based, time phased order point (TPOP) system is used to calculate when and how much to order. The recommended order size is designed to keep the projected on hand balance above the

safety stock level. Approximately one half of the parts are purchased from outside vendors and one half are manufactured by NCR. Parts are also sourced from NCR repair facilities and from the Inventory Recovery Center in Dayton, Ohio. The Inventory Recovery Center salvages usable parts from scrapped and obsolete units. In some cases, when it is cost effective to do so, non-NCR manufactured units are purchased and disassembled to provide third party parts.

Inventory

Service parts are identified by the plant which produces a particular product--a maintainability representative at the plant provides a recommended spares list for each system manufactured. Potentially, hundreds of thousands of spare parts could be stocked; however, NCR stocks only active part numbers--parts with three or more customer orders within the last six months. Over 80,000 parts are maintained in active inventory and all inventory, regardless of location, is carried on the WSPC books. Bar coding and on-line, real-time processing of inventory transactions are used to track inventory throughout the system. Inventory levels for the WSPC are set by item managers based on historical demand with safety stock levels set at two times the mean absolute deviation (MAD) between the six month average demand and actual demand. These safety stock levels normally represent a 90% overall level of service. However, some parts are ordered that have never been stocked and vendor performance delivery of parts

results in a certain percentage of past due orders. The actual service level is 82-85%.

Overall inventory accuracy at the WSPC is maintained through cycle counting. When the WSPC first opened, a physical inventory system was used that took six weeks, utilized 250 personnel, and usually introduced more errors than it corrected. Around 1976-1977, cycle counting was initiated and now net inventory variances are around 1%. A sample count is done each year by auditors; the Finance Department does the cycle counting. Cycle count frequency is based on an ABC analysis by dollar volume; counting frequency ranges from around 4 times a year for "A" items to about every 2 years for "D" items. NCR reviews and reclassifies the items once a year.

Repair/Rework

Certain parts are identified as reworkable by the manufacturing plant maintainability specialist. Parts designated as reworkable are returned by the field engineer to the servicing parts room. Reworkable parts are shipped via truck no less than weekly by the parts clerks/ specialists to a specified repair depot based on geographic location or repair specialty. NCR has seven repair depots in the United States which have the same capability for repair with the exception of a few specialized parts. Additionally, two finished goods service centers at Sparks, Nevada and Bethlehem, Pennsylvania, and the WSPC itself have the capability to repair spare parts.

The repair schedule is controlled by the WSPC's time phased order point (TPOP) system. Parts are held in stock at the repair facility until ordered by an item manager at the WSPC. Just as with a part buy, the TPOP system is used to calculate when and how much to order. When an order is placed, the parts are repaired and shipped to the WSPC for stocking. Any necessary part upgrades or modifications are made by the rework facility at the time of repair.

Transportation

The WSPC ships outbound parts daily by truck and Federal Express. Approximately 35% of the parts are shipped by truck with the principal carrier being Roadway Package System. The remaining 65% are shipped by mainly by Federal Express, which maintains two full time employees in the WSPC shipping department. Routes, rates, and urgency of need are used to determine mode selection.

Generally, parts are locally available 88% of the time. If the FE does not have the part in his personal inventory, it is available from the servicing parts room or from another FE. When a part is not available locally (12% of the time), an emergency order is placed with the parts room or by the FE directly to the WSPC. The part is shipped Federal Express overnight to a destination specified by the FE. If overnight delivery will not meet customer service contract specifications, the District Manager can authorize counter to counter shipment utilizing the most expeditious means of transportation such as Delta Dash or Eastern Sprint

services. (Figure IV-6 shows the FE/service parts interface.)

Joint Management of Parts

Parts are company assets that are managed jointly by the parts specialists and the field engineering organization. The parts management organization in the United States is depicted in Figure IV-7. Spare parts operations support is provided to the 6 field service divisions through centralized management by the WSPC and through parts representatives at the area, region, district, and zone levels. WSPC centralized support has been discussed; the focus of this section will be on the remaining levels of parts support.

The regional inventory managers are tasked to monitor overall inventory levels and to insure compliance with NCR policies. Parts are not stocked at the regional level; main stocking is at each district and a parts specialist at each district office is responsible for inventory maintenance. Parts may also be stocked at the zone level. Parts clerks are assigned at both the district and zone level to perform inventory control functions. Field engineers also carry a stock of high failure parts for their assigned equipment types.

Guidelines for stocking levels are determined by the area and regional inventory managers based on parts activity, usage, and installed machine base. However, stock levels at the district, zone, and field engineer levels are

FE Arrives At
Customer Location

Part Available?

YES → Complete Repair

PMS Update for Parts Usage

Defective Part:

Reworkable	Return To Parts Room
Salvageable	Return To Parts Room
Non-reworkable	Dispose Of Locally

(Approximately 88% of the time a part is available locally [parts room or in another FE's inventory]. 12% of the time an Emergency Order is placed with the WSPC.)

NO	Call Parts Room	Part Available Locally FE Picks Up Part Or It Is Delivered
NO	Call Parts Room	FE Places Emergency Order Part Shipped Federal Express/ Overnight Delivery To FE Specified Location
NO	After Hours	FE Places Emergency Order Direct To WSPC Part Shipped Federal Express/ Overnight Delivery To FE Specified Location
NO	Call Parts Room Or WSPC Direct (After Hours)	Critical Contract Requirements Counter To Counter Shipment Authorized By District Manager Part Shipped As Soon As Possible Via Delta Dash Or Eastern Sprint To FE Specified Location

Figure IV-6. FE/Service Parts Interface.

Director, Inventory Management and Control, WSPC *

Manager of Field Inventory Management, WSPC *

Area Inventory Manager

Region Inventory Manager

Parts Specialist (District) *

Parts Clerk (District and Zone) *

* Inventory stocking locations, parts are also stocked by Field Engineers

Figure IV-7. Parts Management Organization.

ultimately the responsibility of the CSD District Manager and are negotiated with the area and regional inventory managers. Inventory costs are a controllable expense; the district manager must balance service requirements against the cost of inventory. For example, district managers may stock "in case of failure" (low activity/usage) parts as an additional hedge against degraded customer support but must be prepared to pay for the extra investment.

Timing of district parts replenishment orders and order lot sizes are also determined by the CSD District Manager. Field engineers place replenishment orders (usually one-for-one) with the zone or district parts offices. FEs may place emergency orders with the servicing local parts office or directly with the WSPC.

To aid the district managers and FEs, the WSPC provides a monthly listing of all parts carried by FEs compared with parts having activity/usage. This report aids in determining if the FE has the right mix of parts in his personal inventory.

Summary

NCR is a firm that believes a competitive advantage in its markets depends on the ability to service NCR equipment as well as the equipment of other manufacturers. It has organized specifically to exploit opportunities for providing better service by moving customer sales and support management closer to the customer and decentralizing the customer service decision-making process.

Maintainability and serviceability of products is a prime consideration in the design and manufacturing processes.

Inventories of service parts are centrally managed by the Worldwide Service Parts Center and at lower stocking echelons, jointly managed by both the service parts organization and the field service organization. Management information systems are used to track customer files, dispatch repair personnel, and monitor performance of field engineers and installed equipment. The implementation of an RF system, replacing phone links, will further enhance the field service function by allowing field engineers direct access to the on-line parts system and the direct ordering of required parts.

International Business Machines (IBM)

Overview

As the name implies, International Business Machines (IBM) functions in the international arena with worldwide revenues of $69 billion and worldwide net earnings of $6 billion in 1990. Customers include such diverse organizations as the Louvre museum in Paris, Singapore Airlines, Mobil Corporation, the Canadian Post Corporation, and the Burger King Corporation. IBM applies advanced information technologies to assist in solving the problems of business, government, science, defense, education, medicine, and other areas of customer activity.

Since 1986, IBM has implemented an extensive restructuring. Overhead positions--e.g. headquarters staff,

administration, and distribution--have been eliminated and personnel retrained into sales, systems, engineering, programming, and other jobs that directly contribute to growth and revenue. The marketing force has increased 23 percent worldwide over 1986 levels and in 1988, the field service function grew in size adding over 1100 technical hires. Improved production techniques and productivity gains have allowed the reduction of worldwide manufacturing plants from 42 to 33. Worldwide the employee population has been reduced by 24,000 since early 1986 to a level of approximately 383,000 people, with further reductions anticipated. Overall, the company has reorganized to make it leaner and more responsive to customer needs and market dynamics; customer support and service have become important company goals.

IBM's product line includes mainframe computers, midrange computer systems and work stations, personal computers, office equipment, and various software application packages. Additionally, both hardware and software maintenance programs are marketed. In addition to the internal sales and service force, IBM Business Partners--remarketers, agents, application specialists, and dealers--sell selected IBM products or complement them with their own products and services.

Organization

Prior to 1991, the National Service Division or NSD, was responsible for providing after-market maintenance

support to IBM's customers. NSD was headquartered in Franklin Lakes, New Jersey, with a network of support throughout the United States. At the head of the organization was the President of NSD who was supported by two Vice Presidents of Field Operations that had responsibility for the eastern and western United States respectively. Additional levels of the field service management organization consisted of area managers, regional managers, branch managers, and field managers.

In January 1991, IBM reorganized its marketing, maintenance services (field service), and professional service functions (site planning, cabling, relocation, data center design and construction, and information network services). The 1991 reorganization reduced levels of management and combined marketing, field service, and professional services to push decision making closer to the customer and to provide a team approach to solving customer problems. The new organization is portrayed in Figure IV-8.

The U.S. Marketing and Services organization is headed by an IBM Senior Vice President and General Manager. National parts support for field service is provided by the National Distribution Center located in Mechanicsburg, Pennsylvania. Two education centers, located in Atlanta and Chicago, provide initial and follow-on service training for Customer Engineers. Co-located in Lexington, Kentucky, the Digital Communications System (DCS) and the National Service

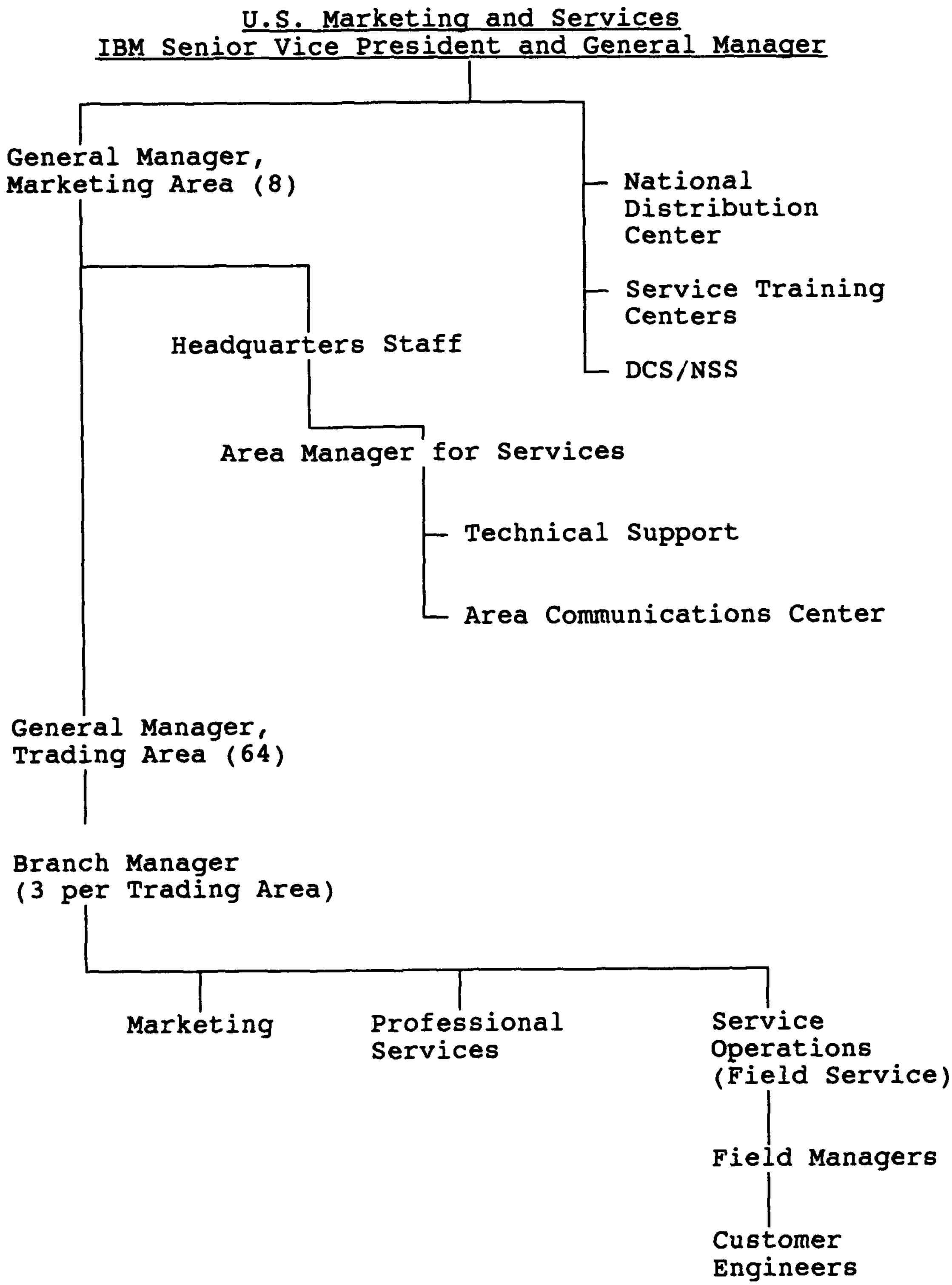


Figure IV-8. IBM Field Service Organization.

Support (NSS) system provide nationwide communications links and information processing of field service data.

In addition to the national support functions, the U.S. Marketing and Services organization consists of Marketing Areas (8) and Trading Areas (64). General Managers for the Marketing Areas are located in Atlanta, Dallas, San Francisco, Los Angeles, New York, Chicago, Detroit, and Washington, D.C. An Area Manager for Services is a member of each Marketing Area's headquarters' staff. This service manager is responsible for the Area Communications Center and technical support groups.

Trading Areas reflect the "team approach" to solving customer problems--each Trading Area consists of three *branches:* Marketing, Professional Services, and Service Operations (Field Service). The Service Operations Branch Manager is responsible for field service functions. Under the Service Operations Branch Managers are 1200 Field Managers and over 15,000 Customer Engineers employed nationwide to provide professional support, fast response, and "quick fix" capability.

Strategy

Competitive Differentiators

In the field service area, IBM customers have identified requirements in three critical areas: services (single source, technical support, operational support), maintenance (fast response, quality fix, personalized service), and responsiveness (flexibility). To meet these

customer needs, IBM offers the following: multi-vendor service management, an automated dispatch/communications system, a multi-level support structure, electronic support systems, an on-line parts logistics system, extensive field service training and education, and personalized service.

For customers with a mixture of IBM and non-IBM machines, IBM offers a one-stop, single service manager program for contract maintenance services. IBM will act as the primary contractor for maintenance services, coordinating predictive/preventive maintenance, engineering changes, equipment changes, and installation services. As the primary maintenance contractor, IBM will perform maintenance on certain non-IBM products identified on a service-approved product list or subcontract maintenance and handle contract administration, invoicing, and billing. In this multi-vendor environment, to service other companies' products, IBM uses third party service providers (independent service companies).

Fast response is ensured through IBM's dispatch/ communication system--the nation's first private, totally digital, two-way communications system. Customers enter the dispatch system by calling 1-800-IBM-SERV, 24 hours a day, seven days a week. There are 8 Area Communications Centers throughout the United States that provide geographical dispatch service as well as system redundancy. Central to IBM service is the customer engineer (CE), and each CE is equipped with a dispatch system portable terminal (PT). The

PT is a two-way communication device that is used for receiving and transmitting information via a key board and liquid crystal display. Typically a service call is transmitted to the CE within two minutes. Overall, the use of the PT has reduced the average service call by 20-25 minutes.

If a CE cannot resolve a problem, he or she has multiple levels of support that can provide assistance. IBM's echelon support consists of three levels of specialist support. Level 1 consists of branch office product specialists who are highly trained in particular product lines as well as area specialists, who provide in-depth knowledge and extensive service experience. Area specialists initiate approaches when the branch office is experiencing difficulty. Level 2 support is the IBM Support Centers. Support Centers are staffed by specialists with an average of 14 years' experience in customer support. The final level of support, Level 3, is known as plant of origin support. When normal diagnostics and local support cannot resolve the problem, product engineers at development or manufacturing plants are available to any IBM CE for telephone consultation. If necessary, plant representatives will travel to the customer location.

For certain machine types and systems, IBM offers a Remote Support Facility (RSF) service. RSF provides a teleprocessing link between customer sites and IBM Support Systems. RSF enables remote specialists to control the

operation of IBM equipment to perform diagnostics and analyze problems. Often problems can be solved without dispatching a CE by transmitting microcode patches (software codes) to assist in problem diagnosis and having the user perform certain corrective actions. If CE dispatch is necessary, problem determination has been performed and a CE action plan has been developed that includes identification of specific tools and part numbers.

Customer engineers have immediate access to a $4 billion nationwide parts inventory through their portable terminals and an on-line parts logistics system. The Parts Inventory Management System (PIMS) processes six million parts transactions yearly and maintains a four-hour delivery level for 90-95 percent of customer requirements. In emergency situations, parts may be pulled from the assembly line.

Before new products are even shipped, trained customer engineers and a technical support structure are in place. IBM customer engineers receive extensive education and training which includes: classroom training, computer-assisted training, system and network training, as well as hands-on product training. Each branch office provides access to the Field Instructional System, an on-line, interactive training program; additionally there are two Technical Education Centers located in Atlanta and Chicago that operate on a three-shift, seven-day-per-week schedule with more than 80 instructors.

IBM stresses a partnership between itself and the customer. Service support is provided by a team. A CE plus two backups are assigned to each customer. The field manager constantly monitors the service delivery process and ensures proper escalating procedures are followed when necessary. In addition to the service partnership, IBM has extended marketing assignments to enable marketing representatives to build long-term customer relationships thus providing a better understanding of both customer product and service needs. For selected large accounts, national customer service executives are assigned to act as liaisons to the IBM service organization and to coordinate service delivery for multiple locations. In 1989, in response to customer requests, IBM restructured its service package to simplify contract administration. The new package, ServicePlan, represents a streamlined service contract in plain English, with all terms and conditions simply stated. The IBM Maintenance Agreement Plan and Multi-Vendor Services are a part of ServicePlan and can be easily tailored to meet each customers' unique business needs.

Corporate Strategy/Field Service Strategy

IBM has always stressed customer service; their current motto states: "IBM Means Service." For the information industry, the last 5 years have been a period of rapid and dramatic change. New technologies and product innovations have increased the number of computer users and generated

demand for new applications, open systems, and standardized products. To ensure customer service offerings match customer demands, IBM uses its own extensive market research, customer surveys, customer visits, user group meetings, and interviews with key customer executives. Industry surveys and competitive analysis are also performed using information from marketing research and industry analysts such as Composit Analysis-Touche Ross; Frost & Sullivan; International Data Corporation; The Yankee Group; Input, Inc.; and Datamation.

In 1985, IBM developed a strategy designed to become leaner, more efficient, and market driven. Markets were selected that offered the best returns and leadership in those markets was pursued by making customer satisfaction the number-one priority. IBM's ultimate goal is to become the world's champion in meeting customers' wants and needs. The restructuring of IBM is designed to achieve this goal. Staff positions have been eliminated and personnel retrained into areas involved with developing and marketing responses to customer needs or servicing customer problems. U.S. development and manufacturing operations were restructured into seven lines of business to provide decision-making and accountability closer to customers.

The same sensitivity to customer needs stressed by IBM at the corporate level is echoed by U.S. Marketing and Services. Marketing and Services listens to its customers and utilizes the same methods as corporate headquarters to

improve customer support: customer surveys, executive forums, customer visits, user group meetings, and executive research. Field managers, the first-line managers, have been assigned the direct responsibility for customer satisfaction. Decision-making and accountability is close to the customer and resides with a person who is familiar with the customer's applications, personnel, and equipment.

IBM Business Partners

To provide field service, IBM utilizes a national service force, company-owned service centers, independent distributors and dealers, and mass merchandisers. In a multi-vendor environment (mixture of IBM and non-IBM products), IBM will serve as a single-service manager.

The Service Operations function comprises the national service force. For certain products, primarily IBM personal computer related products and components, customers can exchange product elements than need maintenance by bringing them to an IBM Service/Exchange Center. These centers are located in major metropolitan areas where product density is high.

Business partners are used to complement the Marketing and Services organization. Business partners represent business alliances developed by IBM to gain access to markets, distribution channels, specialized skills, and new technologies. Authorized, independent distributors and dealers, such as ComputerLand, sell IBM products and also provide service. These independent dealers generally sell

and service IBM personal computers. Additionally, alternate channels of sales and distribution (mass merchandisers, e.g. Sears) are used to market IBM products. In all cases, if a company markets an IBM product, that company may elect to either service that product or sell IBM service contracts with maintenance performed by IBM CEs. Business partners also include third party service providers (independent service companies) such as General Electric or TRW that are used by IBM to service non-IBM products when IBM serves as a single-service manager.

Product Development/Repair Strategy

Located at each manufacturing plant and laboratory are Marketing and Services' personnel known as service delivery planning representatives (SDPRs). (A summary of the field service/manufacturing interface discussed in this and other sections of the case is provided by Figure IV-9.) These SDPRs act as service advocates during product design and manufacturing and ensure that test points, panel access, and modular details are designed into the equipment. They also perform a variety of other functions.

In conjunction with manufacturing and product engineers, SDPRs develop maintenance analysis procedures and automated logic diagrams (flow charts) based on IBM's repair strategy of remove and replace. Central to this strategy is the concept of field replacement units (FRUs), or modules that can be isolated, tested, and quickly replaced.

<u>Service Delivery Planning Representatives</u>

<u>Product and/or Manufacturing Engineers</u>

→ Serviceability/Design/Manufacturing Tradeoffs

→ Recommended Spare Parts (RSP) List for New Products

→ Development of Maintenance Procedures

→ Analysis of Product Performance and Maintenance Levels

- Engineering Changes
- Revision of RSP List

→ Evaluation of New Technologies

- Engineering Changes

→ Technical/Parts Support

→ End Of Support Provisions

<u>Figure IV-9</u>. Field Service/Manufacturing Interface.

These service advocates also develop maintenance packages for new products that include skill level determination, specification of tool requirements, and development of training courses and materials. SDPRs provide technical support by tracking product performance databases, installation problems, and the effectiveness of the product maintenance plan. Finally, service delivery planning representatives serve as a maintenance liaison between the product/manufacturing engineers at the plant of origin and field service personnel/end users.

Engineering Changes

Currently the product life cycle is 5-7 years. During this time, service performed and parts usage on every machine type and model is tracked against service planning projections made by the manufacturing plant of origin. Reports from the Parts Inventory Management System and the Remote Technical Assistance Information Network provide actual use data. Variations are analyzed by the product engineers and the service delivery planning representatives to determine if engineering changes are required.

Engineering changes include operational improvements in quality, safety, serviceability, and reliability. When a change is necessary, it is shipped automatically for customers having an IBM Maintenance Agreement. Customer engineers install the required part or update the machine ensuring that all equipment has the latest configuration; stocked parts requiring the engineering change are also

modified. Field managers receive a monthly engineering change activity report that details the release and shipment of engineering changes. Another management tool, the Time Analysis Report, can also be used by the field manager for daily, on-line tracking of pending engineering changes for his/her assigned CEs.

For parts awaiting rework, engineering changes are incorporated when a demand for the part triggers the rework process. Independent retailers who sell and service IBM products are sent engineering change notices and order as required. The engineering change process is outlined in Figure IV-10.

<u>End of Support</u>

End of support provisions vary by product. Product engineers at the development site or manufacturing plant determine when to stop support. The stop-support decision is based on a number of factors including the age of the product, product population, failure rate analysis, and economic analysis of repair activities. The economic analysis is used to determine the point where the cost to repair an item (e.g. CE training, parts stocking costs) is higher than the revenue generated by repair. When it is decided to stop support for a product, a three year notice is given. Customers with those products are provided a yearly reminder of when support will end. In some cases, on a special bid basis, IBM will support a product beyond the

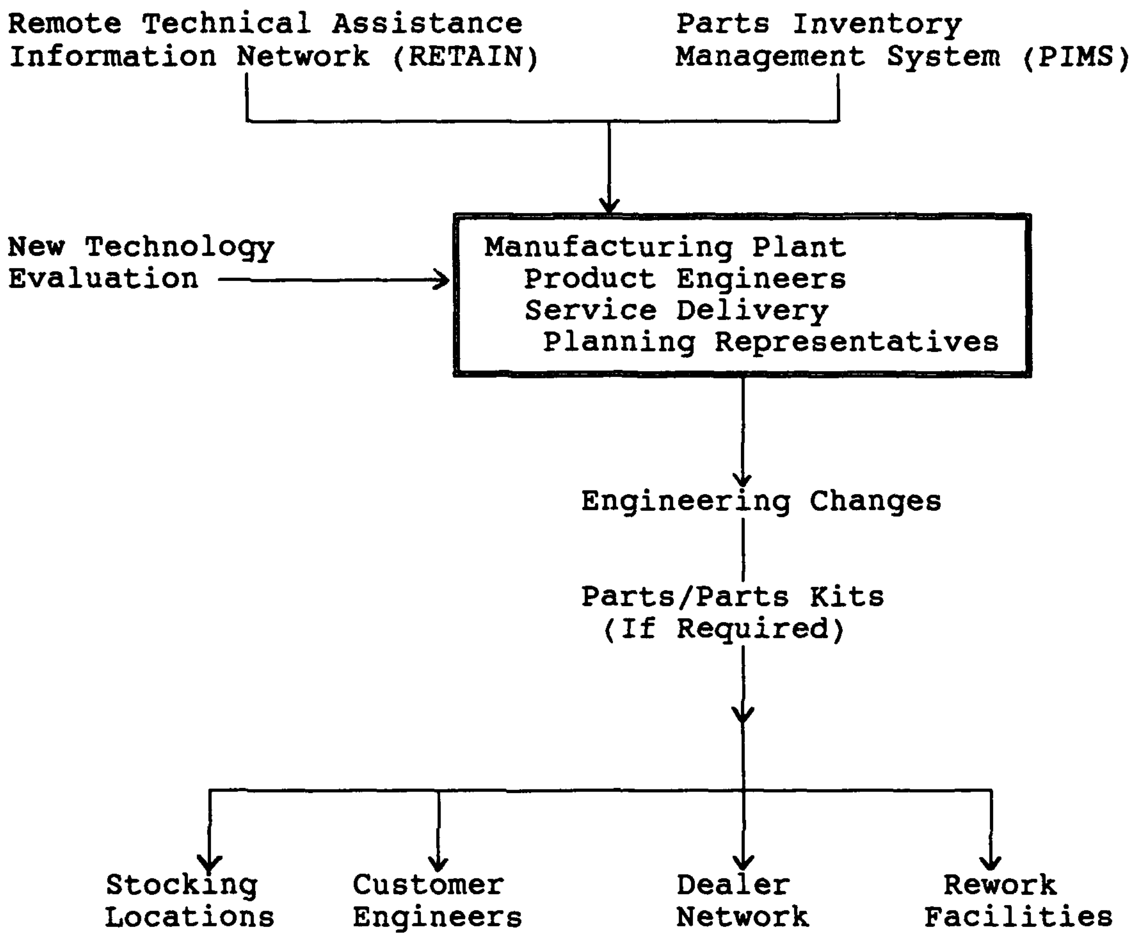


Figure IV-10. Engineering Changes.

three-year period for a specified period of time--subject to parts availability.

Performance Measures

Customer Engineers

Customer engineers' performance is evaluated in three ways: direct contact between the field manager and the customer, customer satisfaction surveys, and reports generated from the National Service Support (NSS) system.

Customer satisfaction is the most important measure of performance. On a periodic basis, the field manager talks directly to the customer to gain a subjective evaluation of how the customer views the CE and his/her work. This direct communication can take the form of a phone call or an actual face-to-face visit. Additionally, a formal meeting is held annually between the field service manager and customer management to discuss service performance. At this meeting, the field manager reemphasizes IBM's commitment to service and conducts a service quality interview. The field manager asks a series of questions designed to evaluate CE performance. Questions include:

1. Does the CE return customer calls in a reasonable time?

2. Does the CE make commitments and keep them? Are the commitments reasonable?

3. Is information on the problem situation and solution communicated to the customer?

4. Is the information communicated to the right level? (The equipment user and his/her supervisor.)

5. Is the customer contacted by the CE in situations other than maintenance calls?

6. Does the CE come by periodically or call to check on system performance, keep the customer informed of upcoming and latest changes, explain why the company is making certain changes, and explain how changes will affect the customer?

7. How does the customer view the CE's responsiveness, competence, courtesy, and general ability to communicate?

8. Does the CE generally fix the problem the first time/within a reasonable time?

A customer satisfaction survey is mailed out annually to all IBM customers. This survey, sent by corporate headquarters, consists of 25 questions and has a 30% response rate. The survey is designed to answer the question: On average, how satisfied are our customers with our service? If problems in certain areas surface, the company performs a more in-depth analysis. An independent firm also performs a telephone survey. IBM is not identified as the survey sponsor; this survey is designed to collect information on IBM and its competitors and their relative rankings on customer satisfaction. The survey is run until statistically significant information is gathered and then sent to corporate headquarters which disseminates the results to lower management levels. Product managers at

the factories also send out surveys to customers to determine not only product performance but also customer satisfaction with service support.

The NSS system provides the computer power, database management, and application programs to link various elements of the on-line support systems. NSS supports, among other functions, service activity reporting, parts inquiry and ordering, dispatching, and a management tracking system. From this system, CEs receive a weekly report that lists every assigned machine that has received service, machines requiring preventive maintenance, and engineering changes pending. Additionally the CE receives a parts analysis report that lists parts checked out, used, returned, and parts that should have been returned as salvage.

The field manager receives the same reports as the CE plus a monthly summarized analysis of service delivered by individual CEs. Additionally, managers may use COMIT (Consolidated On-line Management Information Tool) to access various field service databases and retrieve information. Information available includes: financial performance, parts usage, exceptions that exceed usual or average service requirements, inventory levels and activity, dispatch information, engineering changes, and field activity. Formatted reports are available or a manager may design his or her own report based on select interest items. There is also a provision to have these select items automatically

presented each day as a "morning report." For example, the field manager may want to know how quickly assigned CEs respond to customer calls. All of these reports--on-line, weekly, and monthly--provide a variety of information that can be used by managers to monitor and evaluate CE and service system performance.

Current performance measures, both technical and subjective, were established based upon internal company requirements and customer input. Planning sessions were held with customers to determine what, from a customer perspective, was important. The Atlanta branches did some leading-edge work in establishing performance objectives based on parts availability, call backs (how many times a customer calls before the CE acknowledges the call or shows up on site), how long it takes to get on site, and CE training on products.

Revenue/Expense Measures

The Service Operations function operates as a profit center and is evaluated based on revenue/expense. When a machine is developed at the plant, product engineers, manufacturing engineers, and the service delivery planning representatives establish expected performance levels for the product. A service cost estimate based on factors of parts expense, mean time between failures, travel time, and to some extent, repair time is developed. This cost estimate is used to determine product profitability. For the field service function, actual expenses are compared

against projected expenses by product. Field service expenses consist of overtime, parts usage, travel, training, salary, and miscellaneous office expenses. Branches are tracked against revenue also. Based upon the installed base and the marketing product plan for new sales, historically, a certain percentage of maintenance revenue will be generated.

Customer Complaint--Formal Procedure

If a customer complaint is elevated to an executive outside of the Service Operations' branch (Trading Area or Marketing Area General Manager, Vice President of U.S. Marketing and Services, or IBM Chairman of the Board), a formal complaint procedure is initiated. The complaint is logged and the executive that received the complaint has five working days to reply, by letter, to the customer with resolution. The applicable branch manager must provide information concerning the complaint to the executive, coordinate with the customer, and provide an action plan/timetable for problem resolution. The executive will call the customer to check on progress.

In the past, complaints were tracked annually at the Division level. Tracking was done by number of complaints and number of justified complaints. Now the goal is to deliver excellent service with no complaints. IBM believes that the customer should be able to resolve any problem at the branch/field manager level. Two goals of the company restructuring were to provide a sharper focus on customers

and to drive decision making and accountability closer to customers. Based on this restructuring, field managers are assigned direct responsibility for each customer's service satisfaction.

Information Flow

Intra-Branch Information Exchange

For the majority of accounts, particularly the small to medium-sized ones, the CE sees the customer more than the marketing representatives. In the past, a number of attempts were made to formalize a process that would make it easier for CEs to pass leads to marketing: a phone number the CE could call, a card to fill out, even the portable terminal was used to input leads automatically to marketing representatives.

A goal of the 1991 reorganization of NSD, its placement under Marketing, and the establishment of Trading Areas was to facilitate the exchange of information between functional areas at the branch level. Maintenance, marketing, and professional services personnel are co-located in the same offices and interface and exchange information on a daily basis. This facilitates a team approach to customer needs; a cross-functional team that offers a complete, "packaged" solution to customer problems.

Management Information Systems

The National Service Support (NSS) system consists of information systems, database management, and application programs designed to support the field service organization.

The Digital Communications System (DCS) links NSS with the CEs' portable terminals, area dispatch operations, branch locations, and various IBM support centers.

Through the portable terminal, the CE is linked to the entire IBM service organization. The NSS system allows the CE to access customer information, to determine parts status and locations, and to directly communicate with other CEs, management, and technical specialists. A variety of reports are also available from NSS to assist field service managers (e.g. the previously mentioned Time Analysis Report and reports generated by the Consolidated On-line Management Information Tool), product and manufacturing engineers, and service delivery planning representatives. Two important portions of the NSS that provide technical service information and historical repair actions are the Technical Management System (TMS) and the Remote Technical Assistance Information Network (RETAIN) (see Figure IV-11).

TMS is designed to provide field service managers, as well as plant and headquarters personnel, with technical information required to track product performance and service quality. All service activity reported by Service Operations' field personnel is processed by the Quality Service Activity Report/Processing (QSAR/P) component of the TMS. As a CE progresses through the service call, information is input into the QSAR/P via the customer engineer's portable terminal. A formatted report, the Quality Service Activity Report (QSAR), asks for all

<u>CE Service Data</u>
CE Identification
Machine Type/Serial Number
Time Service Call Placed
Travel Time
Time of Arrival
Duration of Call
Duration of Fix (Actual
      Maintenance Time)
Type of Fault
Failed Part Number
Problem Description
Maintenance Activities

↓

NSS (TMS/RETAIN)

↓

<u>Reports</u>

CE Managers

Manufacturing Plant
- Engineering
- Quality Assurance
- Service Delivery
  - Planning
  - Representatives

<u>Figure IV-11</u>. Major Field Service Information Systems.

pertinent information regarding the service call to include customer engineer identification, machine type, serial number, time the service call was placed, problem, travel time, time of arrival, duration of call, duration of fix, and on selected machines, codes that are related to the customer location, type of fault, and failed part number.

The QSAR/P passes field service information to the Consolidated Product Performance Reporting System (CPPRS). CPPRS combines service activity with inventory and maintenance plan data to produce weekly updates to three interactive files. The three interactive files provide the capability to identify product performance exceptions by machine type and machine type serial number. Additionally, trends and specific field service activity can be identified by company, customer location, and service delivery locations to include parts use and engineering change activity.

Field service managers can retrieve and monitor on-line reports when desired through their office PCs; variances out of tolerance with machine type/model national averages are flagged to call immediate management attention. The manager can then review the service report data associated with the flagged item to find out the root cause--the detail behind the problem. For example, the CE dispatched may not have had the proper training to fix the machine. Parts may not have been available. Sometimes a visit to the customer may be necessary. There may be a problem with the machine

location in the customer's work place or the machine operator may need additional training. The ability of the system to review pertinent data, note variances from nationally established averages, automatically flag out-of-tolerance variances, and provide access to detailed background data for correction of problems is a great asset to field service management.

RETAIN provides a historical database of service calls and includes problem symptoms, determination, and fix by customer and product. Specialists can assist CEs experiencing repair problems by accessing RETAIN and searching for the same or a similar problem encountered and previously solved. "Rediscovered" fixes prevent time being wasted on a problem that has previously been solved.

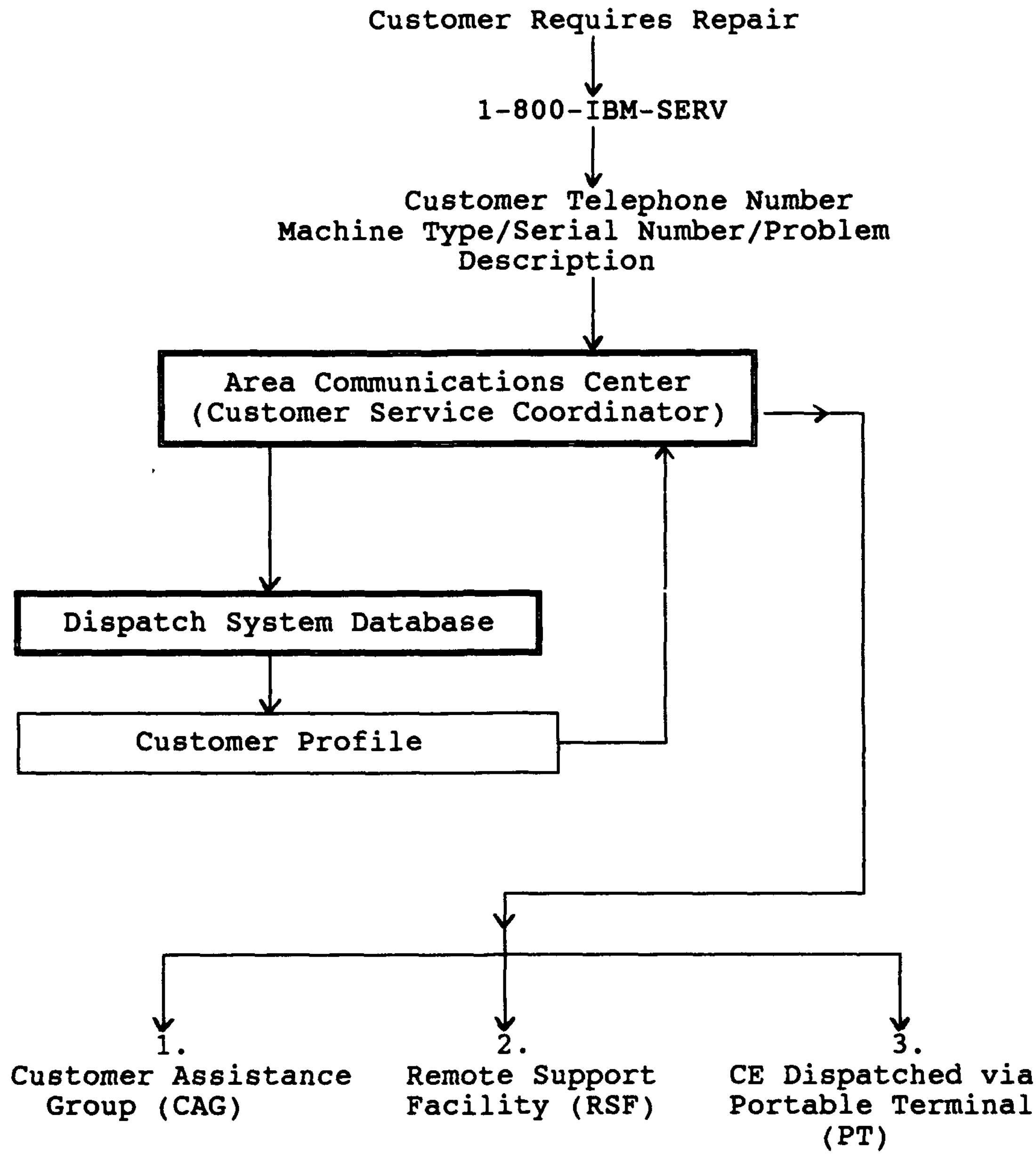
Service Operations

Customers are connected to IBM service by calling 1-800-IBM-SERV. The call is routed to a customer service coordinator (CSC) at one of eight automated Area Communications Centers based on the customers' geographic location. Area Communications Centers are redundant and if one center is overloaded with calls or goes down, any of the others can automatically handle the service requests. The centers are manned 24 hours a day, 365 days a year. The customer provides his/her phone number which allows the customer service coordinator (CSC) to access the customer record, or profile, in the dispatch system. The customer then provides the machine type, serial number, and specific

problem description. The machine type provides the identification of the responsible CEs (primary and two backups) or the appropriate remote support group. As depicted in Figure IV-12, the service call can flow along one of three different routes.

For certain critical system units, calls are directed to Customer Assistance Groups, which consist of highly skilled support personnel familiar with the particular machines. Members of these groups diagnose and often provide the solution to the problem over the phone, eliminating the need to dispatch a CE. In approximately 30% of the calls, operation can be restored within 30 minutes without dispatching a CE. If it is necessary to dispatch a CE, the Customer Assistance Group has already performed problem determination and dispatches parts, tools, and a maintenance action plan concurrent with CE dispatch to minimize downtime.

To enhance service response, Remote Support Facility (RSF) support is offered for the AS400, 303X, 308X, 3090, 4300, and 9370 systems. When the CSC directs a call to the RSF, remote equipment diagnostics can be run by the RSF utilizing a teleprocessing link between the RSF and the customer system. For certain systems, the AS400, 309X, and the 9370, an extension of the RSF support is the call-home function. The call-home feature enables automatic calling from the equipment directly to the support facility. The problem can be analyzed and often corrected via this link.



<u>Figure IV-12</u>. IBM Service Operations.

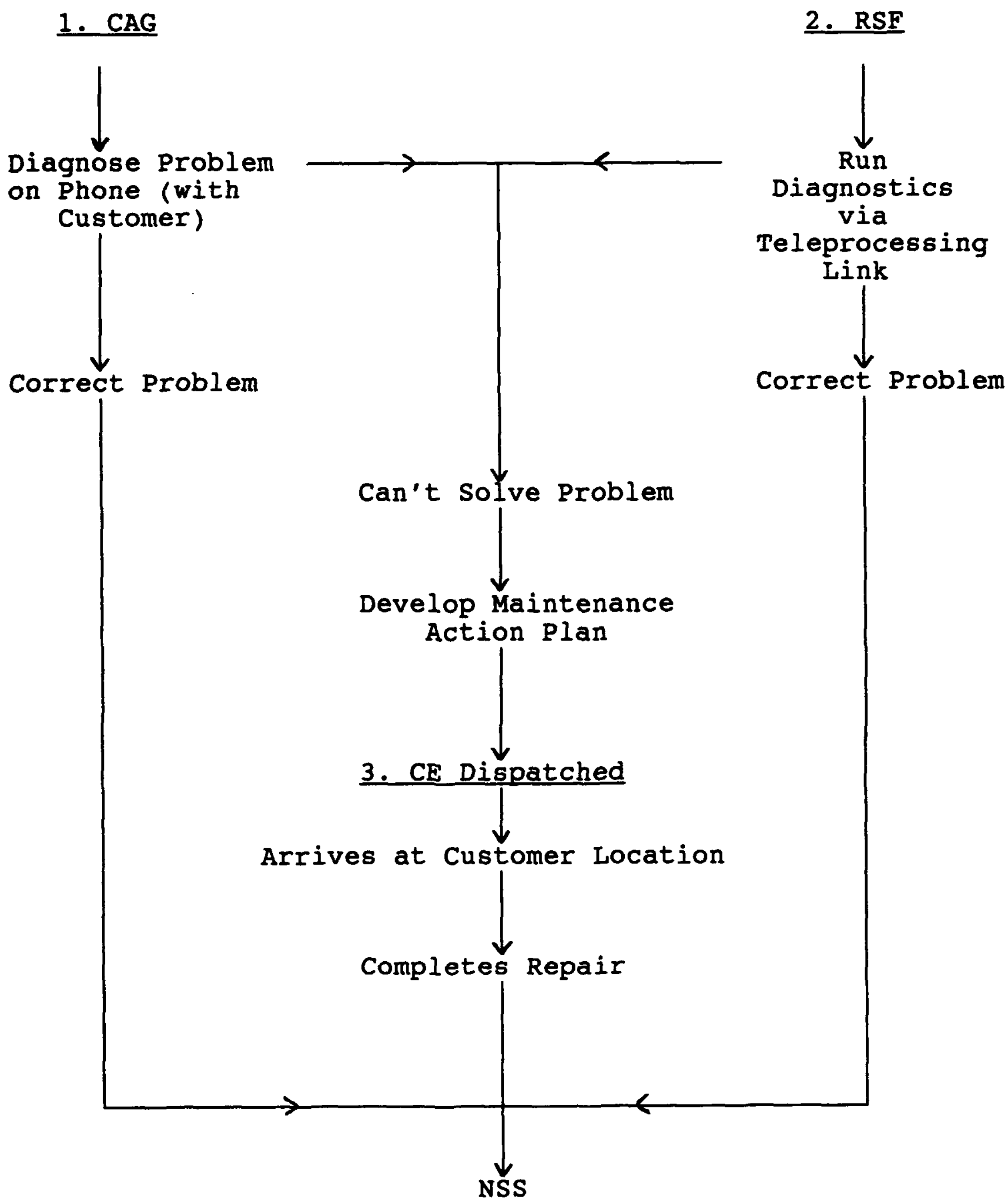


Figure IV-12. Continued.

If a CE must be dispatched, an action plan is transmitted to the CE that includes specific part numbers and identifies any special tools.

If the CSC determines a CE should be dispatched, the problem information is transmitted to the appropriate CE via the Digital Communications System (DCS) to the portable terminal. The portable terminal can store service call information and acknowledges receipt of the information automatically. The terminal will beep to alert the customer engineer of a dispatch call. If the primary CE is unavailable, the customer service coordinator will dispatch the call to one of the two backup CEs. As the customer engineer completes his work, Quality Service Activity Report information is transmitted via the portable terminal to the National Service Support system for processing.

If the CE encounters difficulty in performing the assigned maintenance call, an increasingly specialized hierarchy of technical experts is available. At the branch level, product support trained customer engineers (PSTCEs) are available. These customer engineers are highly trained in particular product lines and understand not only the how-to-repair techniques but also function and application information about a product. Many have spent up to a year in the manufacturing plant to gain product knowledge and additional diagnostics.

The next echelon of support is the area designated specialists (ADS). ADS are located in both branch and area

offices and act as consultants on difficult-to-resolve problems. Also located at the area offices are Technical Assistance Groups (TAGs). The TAG is a team of highly skilled and experienced technical specialists that handle unusual service problems. The product support trained customer engineers, area designated specialists, and the Technical Assistance Groups comprise what is known as Level 1 Support.

Level 2 Support consists of 560 specialists located in IBM support centers throughout the United States. These specialists have an average of 14 years' experience in field service and are experienced with and trained on a wide range of IBM products. When normal diagnostics and Level 1 and 2 support cannot resolve the problem, Level 3, or plant-of-origin support is invoked. The service delivery planning representatives serve as a liaison between the customer location and the manufacturing plant of origin. Both service delivery planning representatives and product engineers are available for telephone consultation and if required, will travel to the customer location for consultation.

Service Parts Management

Reliability, Availability, and Serviceability Groups (which include the service delivery performance representatives) at the manufacturing plants determine service parts for each new machine type. A Recommended Spare Parts (RSP) list for each machine type is developed

which specifies parts to be stocked at each echelon or level of the parts stocking system. The RSP list is periodically updated based on part failure rates, engineering changes, and equipment upgrades.

IBM's service parts logistics system is known as the Parts Inventory Management System (PIMS) and yearly handles 6 million parts transactions for over 26.3 million line items valued at $4 billion. PIMS tracks inventory by part number at all stocking locations and for 90-95% of customer requirements, parts are delivered within 4 hours.

Stocking Echelons/Transportation

The parts stocking system consists of 5 levels ranging from the individual customer engineer up to and including the plant of origin. Level 1 (collectively known as "outside locations") consists of 15,000 locations and includes trunk stock and card caddies (carried by the CE), branch offices, customer locations, and parts vans. Trunk stock and card caddies contain high failure items as well as a selection of spare parts and cards to assist the CE in problem determination. Branches are stocked with a parts mix based on the type and number of machines installed in the geographic area. For some larger customers, customer unique spare parts are stored on-site to eliminate travel time by CEs to obtain necessary parts. Specially designed parts vans are stocked and available to some branches to facilitate parts delivery and availability. Approximately

one-third of the total spare parts inventory is located at Level 1 locations.

Ninety emergency parts stations make up Level 2. These parts stations are selected branch offices that are strategically located to provide the widest area of distribution and the quickest possible delivery. They are stocked with a larger inventory of parts. Level 3 consists of 5 Field Distribution Centers that offer parts not stocked in branch offices. These centers are strategically located in major metropolitan areas and serve as regional distribution centers to ensure necessary parts are within a few hours of the customer site. The Field Distribution Centers are contract operations run by non-IBM personnel and utilize private couriers. The centers provide backup for emergency situations and perform replenishment services to the lower levels. To supplement the support provided by the 5 Field Distribution Centers, IBM also utilizes the Federal Express Business Logistics Warehouse located in Memphis, Tennessee.

The National Distribution Center (NDC) located in Mechanicsburg, Pennsylvania, provides Level 4 of parts support. This center provides 24-hour emergency parts service for orders that cannot be satisfied locally and replenishment parts for all lower levels to include independent dealers, third party maintainers, and self servicers. Inventory planning personnel at the center are responsible for procurement, planning, and maintenance of

the entire parts network. NDC distribution operations personnel handle transportation, warehousing, and packaging of parts. The PIMS system is also located at the National Distribution Center.

The final level, Level 5, is the manufacturing plant of origin. Just as service consultations and support are available from the manufacturing plants, so too are parts. However, generally 95-97% of total maintenance parts demand is handled by the first four levels. The five levels of the parts management organization are displayed in Figure IV-13.

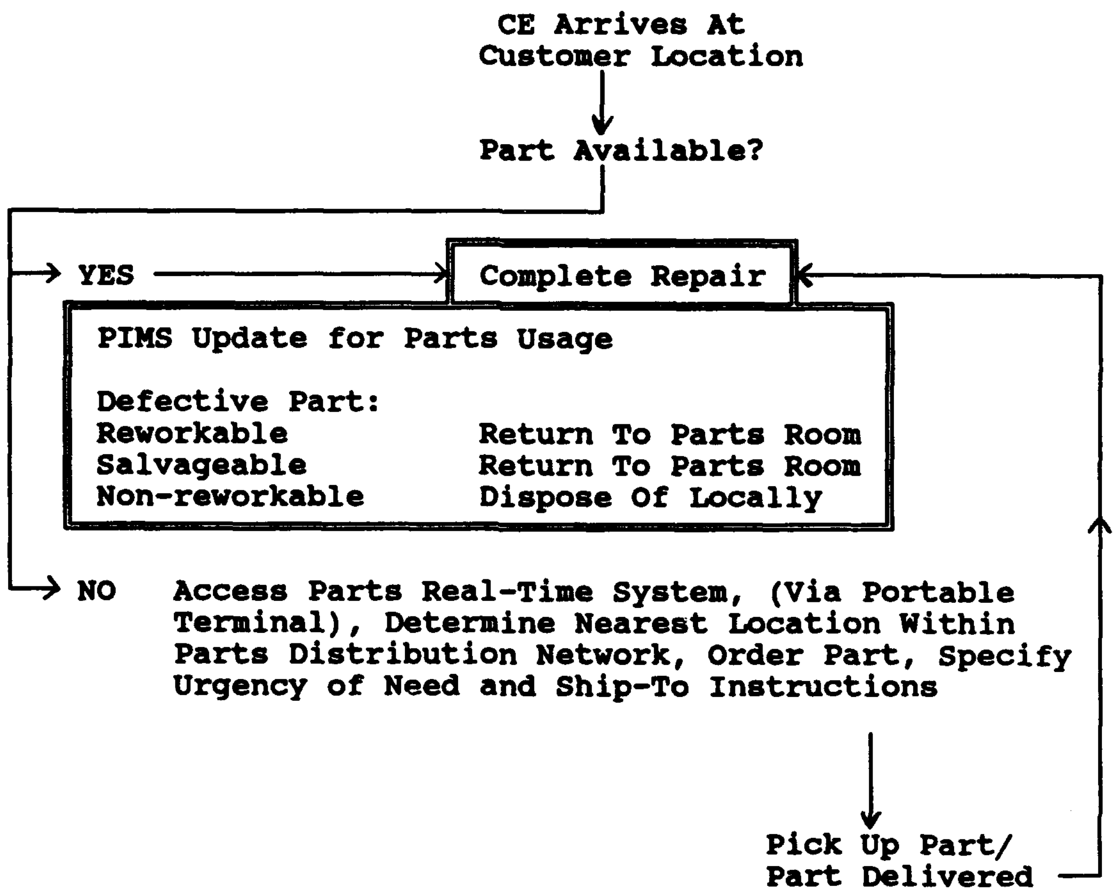
Customer engineers have access to IBM's on-line parts logistics system through their portable terminals. Inventory status and locations are available and the Parts Real-Time System, an on-line parts location program that is part of PIMS, handles emergency part requests. The Parts Real-Time System allows the CE to determine the nearest location of a specific part in the distribution network and to place an order for that part. If a CE does not have the required part, he may pick up the part personally, have the part delivered by an IBM parts van, or utilize courier service for overnight delivery. Figure IV-14 portrays the CE/service parts interface.

<u>OPTIMIZER</u>

OPTIMIZER is a multi-echelon inventory system developed and recently implemented by IBM to provide optimal control of service levels and spare parts inventory. It has permitted a 20% reduction in inventory while maintaining or

Level 5	Manufacturing Plant
Level 4	National Distribution Center
Level 3	Field Distribution Centers
Level 2	Emergency Parts Stations
Level 1	Outside Locations

Figure IV-13. IBM Parts Management Organization.



<u>Figure IV-14</u>. CE/Service Parts Interface.

improving service levels. OPTIMIZER consists of a periodic review, multi-echelon, stochastic model with prioritized demand classes, shortage expediting, fixed lead times, and two supply sourcing network structures--one emergency and one replenishment. The model also includes reorder point (ROP) parameters for each part at each location and stocking echelon, provisions for parts commonality, and demand linkages from echelon to echelon (Cohen, Kamesam, Kleindorfer, Lee, & Tekerian, 1990, p. 72).

All key products are on the OPTIMIZER system. Service parts for new products are added after three to six months demand data are available. OPTIMIZER forecasts parts stocking levels, establishes a reorder point, calculates an economic order quantity (EOQ), and provides automatic ordering and shipping of replenishment parts for stocking levels 2, 3 and 4 when the reorder point is triggered. Level 1 stocking is controlled by the customer engineers. CEs are assisted by Parts Administrators at the branches. Parts Administrators work with customer engineers to check and verify parts levels, make adjustments, and manage the physical inventory. A monthly reorder recommendation is sent to the customer engineers based on parts usage, but it is not binding. CEs are close to the customer and may be aware of pending changes in the customer installed base. To check the accuracy of inventory data a stratified sampling technique is used. Each inventory location is sent a list of part numbers for a physical count. If the count is not

in agreement with the calculated stock levels, a recount must be taken within a month.

OPTIMIZER is integrated with PIMS. The two systems allow IBM to forecast demand, establish stocking objectives at all locations based on cost/service level, automatically replenish stocks based on calculated reorder points, link each customer machine to a list of service parts numbers required for support, and track direct and backup parts support locations for each field installed machine by machine type, model, and serial number. The basic performance measure for PIMS is the Parts Availability Level (PAL). PAL is a measure of the fraction of parts' demand that is filled immediately from on-hand stock at a stocking location.

Rework

Certain part numbers are coded as returnable; these parts are returned by the CE to the branch parts center. The branch office ships, on a monthly basis, these parts to one of three used parts return centers. At the return centers, parts are sorted and, based on part number, are sent to: manufacturing plants (for failure analysis), rework vendors, the IBM repair center (Dayton, New Jersey), precious metal recovery, or special environmental disposal. For reworkable parts, the repair schedule is driven by inventory planners at the National Distribution Center.

Summary

IBM is a corporation with an international focus and a strategy for growth based on market-driven quality--quality based on customer-perceived perfection of every IBM offering and customer contact. Recent corporation-wide reorganization efforts have been designed to streamline operations and provide improved responsiveness to customer needs.

In the area of hardware customer services, IBM has recognized the need to consolidate marketing, professional services, and field service functions. All three functions complement one another and now provide the customer with "one-stop," hardware purchase, installation, and maintenance at the Trading Area level.

For field service operations in the United States, IBM provides a nationwide communications/dispatch system, extensive databases of field service information, and a sophisticated parts management system. To meet the demands of the multi-vendor service environment, a program of alliances with third party repair companies has been developed.

Responsibility for customer satisfaction has been pushed to the lowest management level: 1200 field managers located throughout the United States; first-line managers who are close to and knowledgeable of the customer.

Amdahl Corporation

Overview

Amdahl Corporation was formed in 1970, and after five years of research and development, installed its first computer at NASA's Goddard Spaceflight Center in New York. Amdahl designs, develops, manufactures, markets, and services large-scale data processing systems concentrating on one segment of the data processing market--large system users utilizing the IBM System/370 software and extensions. In addition to large, general purpose mainframe computers, the company's product line includes data storage systems, data communications products, software, and educational services.

Amdahl currently employs 8,200 people worldwide and currently serves customers in more than 25 countries. Corporate headquarters are in Sunnyvale, California with manufacturing plants located in northern California; Dublin, Ireland; and Ontario, Canada. Fujitsu Limited has been a strategic partner since the early 1970s and is a major investor, owning approximately 45% of Amdahl common stock. Fujitsu is a research and development partner and also supplies semiconductors, subassemblies, components, and in some cases finished goods built to Amdahl specifications. Additionally, Fujitsu distributes Amdahl processors in Japan, Brazil, Spain, and South Korea.

There are currently over 1500 Amdahl central processing units in operation used by a variety of organizations:

corporations, governments, universities, and research foundations. In 1989 revenues surpassed the $2-billion mark for the first time. Processors (mainframe computers) make up approximately 70% of total revenue, 13% comes from maintenance, and the remaining 17% is produced by communication products, software, educational services, and storage products.

In 1990, for the second year in a row, Amdahl was ranked by an independent survey as first among mainframe vendors in overall customer satisfaction. This same survey, performed by Datapro Research Corporation, ranked Amdahl first in 19 of 25 hardware service categories including mainframe reliability, maintenance, and service/technical support. Amdahl Corporation is committed to long-term research and development, technological leadership, quality improvement, and the use of advanced manufacturing technologies and robotics.

Organization

A corporate Vice President, Customer Services, Worldwide heads Amdahl's customer service organization. Amdahl's U.S. field service operations are managed by a Vice President, Customer Services, U.S. Operations. The United States is divided into four geographic regions each headed by a director. Each region is further divided into districts with approximately four districts per region; a district manager is in charge of each district. Field managers comprise the first level of management and

supervise from 10 to 12 field engineers (FEs). There are approximately 700 field engineers serving the U.S. market. U.S. Operations is supported by corporate (Customer Services, Worldwide) financial, personnel, training, and administrative resources. Corporate also manages two major field service support operations located in Sunnyvale--the Amdahl Diagnostic Assistance Center (AMDAC) and the Customer Services Center (CSC). A Manager of Logistics serves on the VP, U.S. Operations staff and manages parts support. The organization is portrayed in Figure IV-15. Field service operates as a profit center.

Compared to its major competitors (NCR, IBM, Unisys), Amdahl is a relatively small company both in terms of personnel and installed products. Multi-function team work is the norm throughout the company. When a customer purchases a new system, system assurance reviews are provided by an Amdahl team consisting of representatives from marketing/sales, field service, and engineering. These reviews cover system performance, operating instructions, and support procedures. Representatives from Customer Services are assigned to new product design teams and to manufacturing plants to serve as advocates for maintainability and to assist in the determination of repair levels for various components. Cross functional teams (e.g. manufacturing, marketing, services) analyze product performance and initiate actions to improve reliability,

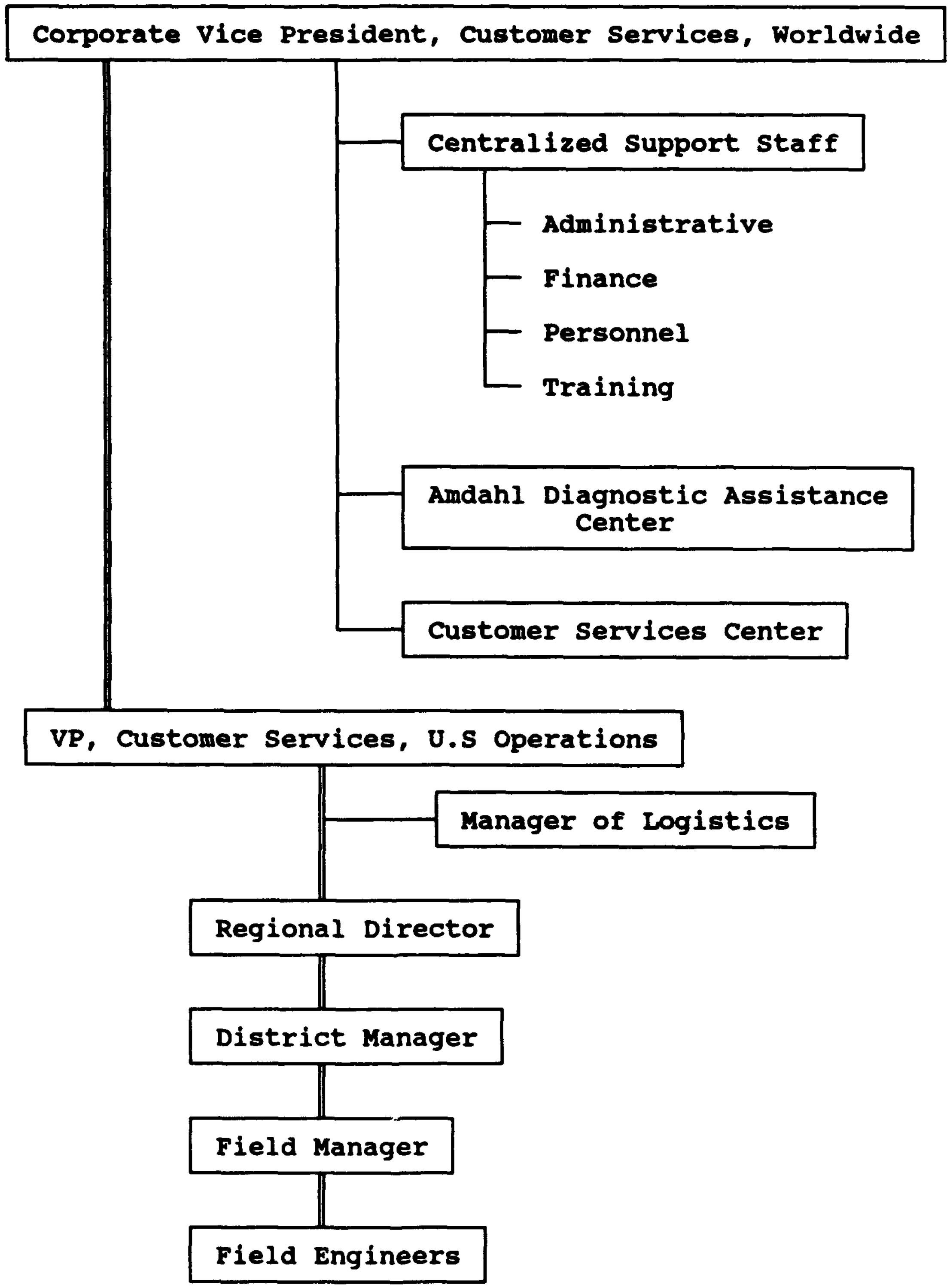


Figure IV-15. Customer Services Organization.

availability, and serviceability not only of existing products but also of future products.

Strategy

Amdahl is consistently among the top U.S. computer companies in terms of research and development expenditures; the company believes that a commitment to long-term research and development is a prerequisite to success. Technological leadership has always been an Amdahl goal--in the product manufacturing process, in product testing, in product maintenance, and in the products themselves. Amdahl's customers demand high performance products (high throughput capacity and fast response times) and products/systems that provide high levels of availability. Recognizing that availability is as important as performance to many customers, Amdahl places a high emphasis on customer service and support.

Zemke (1989) documents the operations of 101 companies that provide exceptional customer service. Amdahl is cited as a company whose emphasis on technical service and responsiveness to customer concerns has proven to be an effective competitive strategy (p. 399). Representatives of the company point out that a customer's system problem is an Amdahl problem. Field managers are expected to understand the customer's business requirements and to develop service plans to support those needs (p. 402).

Service Innovations

Amdahl product lines are designed to be expanded and upgraded; field upgradeability allows for the expansion of machine capabilities at the customer location without the cost of replacing the machine and with minimum disruption to customer availability. Remote diagnostics, the analysis and evaluation (and sometimes repair) of computer malfunctions, was pioneered by Amdahl. Remote diagnostics reduce both downtime and repair expense; problems can often be detected and corrected before they impact system availability. Another innovation, patrol circuitry, scans the computer's main storage, expanded storage, and parts of control storage to detect and correct intermittent errors. Patrol circuitry also initiates repair actions before error conditions become severe. Finally, Amdahl processors are designed to allow field engineers to perform maintenance during operation. While maintenance is being performed, the customer loses access to only a small part of the processor's resources.

In addition to service innovations, Amdahl emphasizes product reliability that exceeds prevailing industry levels and performs extensive component testing during development and production. Half of the manufacturing time is devoted to testing. Component and subassemblies are first tested at the lowest possible unit level. After assembly, the entire processor is tested under heavy work loads, demanding conditions, and for extended periods of time before shipping.

In 1982, Amdahl created Reliability Improvement Teams (RITs) to identify problem areas that significantly impact customers and to improve reliability, availability, and serviceability (RAS) of future systems. These cross functional teams provide a proactive approach designed to detect and eliminate problems before they occur. RITs establish company-wide reliability goals and identify the resources needed to meet those goals; weekly meetings are held throughout the company. Product reliability improvements have resulted through the design and construction of more reliable systems. Additionally, improvements in remote diagnostics have resulted in an improved mean time between unscheduled interruptions (by more than a factor of 2) for the Amdahl 5990 computer mainframe. Reliability Improvement Teams were also instrumental in the development of a centralized customer problem/solution database. This database reduces engineering research time and provides field engineers with a faster solution to customer problems.

Engineering Changes Program

Amdahl's computer products are large, general-purpose mainframe computers. Perhaps the best way to describe Amdahl's engineering change process is through an example. In 1988, IBM announced the introduction of a new industry-standard architecture and operating system for the 1990s--Enterprise Systems Architecture or ESA. Amdahl was faced

with the challenge of achieving compatibility of ESA and Amdahl processors.

A team approach (ESA Development Team) was implemented. Two hundred and fifty people were involved in the project performing tasks ranging from designing new hardware to running assurance tests. Representatives from engineering, customer service, manufacturing, and technical publications were all included on the team. The ESA Development Team solved the implementation problem for new and existing systems; the next task was the modification of systems in the field.

Corporate task force teams were used to plan the updating of systems at customer sites. One team developed a new field installation manual designed to allow installation team members to work on the system simultaneously, minimizing downtime. Another team developed shipping procedures that provided for consolidation of documentation and equipment into one shipment. Packaging, in the form of plastic boxes, was developed that was reusable and eliminated the need for internal packaging material. The ESA Development Team also delivered technical education classes to field engineers to ensure the quality of the installation process was not compromised. Regional coordinators were designated to schedule all ESA implementations (Amdahl, 1989, pp. 8-12).

Although the ESA implementation was a major technological challenge, the engineering change process

flows the same for less than major changes. An audit, begun in 1988, to analyze and improve the engineering change process concluded that integration of departmental services (and the resulting reduction of duplicate effort) would greatly simplify engineering change upgrades at customer sites. Task force teams, composed of members from various departments, are utilized for all engineering changes. Engineering changes can result from Reliability Improvement Teams' suggestions, research and development activities, major technological changes within the industry, and from field engineer inputs. The Amdahl Diagnostic Assistance Center (AMDAC) serves as an official conduit between Customer Services and Amdahl's engineering function, passing suggested changes from the field to design engineering.

Field change orders are communicated to field engineers via Technical Information Bulletins. The response to the field change order varies. If the order corrects a safety problem or a problem that may affect the data integrity of the customer's system, immediate action is required. If parts are involved (versus maintenance procedural changes) they are automatically sent to the field engineer. If the change is a minor performance or reliability upgrade, the FE may delay the change until the next scheduled maintenance period.

As mentioned, Amdahl products are designed to allow expansion and upgrading. The product life cycle can thus be extended, but this extension is not indefinite. Support for

the 470 series of processors was recently discontinued; Amdahl had provided service for 10 years. Customers who elected to retain the 470s were provided the opportunity to purchase a "last buy" of parts from Amdahl.

Third Party Service

Amdahl has traditionally performed service only on its specific products. A current trend in the computer systems repair market is the one point of contact, single manager for a company's account (even though that company may have many brands of computer products). To respond to this trend, Amdahl now provides the single manager option; however, Amdahl does not perform actual service on nor stock parts for other companies's products. Instead, third party service providers are utilized to provide service and parts.

Performance Measures

Corporate Headquarters dictates the areas of interest and performance measures for Customer Services. A Customer Satisfaction Survey is prepared annually by corporate. In order to increase the response rate, it is hand-delivered to all customers by field managers. Both customer service and marketing performance is measured. For field engineering, such areas as response time, parts deliveries, and system availability are measured. There are also questions about the customer's perceptions of the field engineer--knowledgeable, courteous, appearance. The corporate survey allows the tracking of service performance down to the field level. Survey feedback is supplied to the regions. The

corporate sponsored survey is supplemented by purchasing industry surveys from such organizations as Customer Satisfaction Research and the Ledgeway Group. Corporate data is cross-checked with these independent sources.

A monthly Competitive Analysis Report (CAR) is prepared for each region to track field service performance. Information for the report is extracted from the FAST (Field Activity Support Tracking) system. The CAR consists of the following measures:

1. Depot parts out over 48 hours--This measure tracks high value (depot) parts held by field engineers. High value parts are centrally managed by the Manager of Logistics and his staff. When a field engineer requests a high value part to repair a system, the part must be installed and the defective part (or the same part if the part was ordered incorrectly) returned to the parts management system within 48 hours.

2. Overdue appraisals--Field engineer performance appraisals are tracked by due date.

3. Open documents (over 10 days in transit to site)--Field engineers must close out parts shipping documents by acknowledging receipt of the part.

4. FCO (Field Change Order) returns (transit times over 7 days)--Products are often upgraded by replacing parts; the existing part is removed and the improved part is installed. The replaced part must be shipped back to the rework facility for salvage or upgrade.

5. Alert and escalation nonconformances--Amdahl policy requires the field engineer, when confronted with a service problem, to alert management and to request problem assistance. If a field engineer fails to do this, the repair is unnecessarily delayed.

6. R+ outages--Customer accounts that have experienced an unusual number of failures are placed on a "hot list" and are closely monitored.

7. Part returns to HQ, damaged/unproperly packed--Applies to parts shipped to the Sunnyvale rework facility.

8. Documentation, missing or improperly filled out--Applies to parts shipped to Sunnyvale.

9. GA patches not installed over 60 days--Software upgrades that affect or modify system performance.

10. FCOs over 90 days--Hardware upgrades that affect or modify system performance.

11. System Assurance Reviews--System assurance reviews are required within 30 days of system/product installation for all new customers and for existing customers that receive a new system, a new central processor unit (CPU), or a CPU upgrade.

Performance measures for managers are grouped into three areas: expenses/revenues (E/R), employee satisfaction, and customer satisfaction. E/R measures are based on targets set by the Corporate VP, Customer Services. Revenue targets are based on the installed base of equipment, number and type of service contracts, and

value-added services (system level educational services and consulting services: performance analysis and capacity management, data processing planning, data center management, network management, and database/data communications management). Expenses include such standard accounting measures as direct labor, overtime, travel, and training. Employee satisfaction is gauged by annual surveys.

Customer satisfaction is measured by the Corporate Satisfaction Survey previously discussed. Field engineers and managers continuously work with customers to solve problems and to prevent problems from occurring. "Do it right the first time" is Amdahl's standard of performance. In addition, visitors to the corporate headquarters are often invited to meet with the Chairman of the Board or the CEO to discuss Amdahl products and customer service perceptions. Amdahl has consistently received high customer satisfaction ratings but if a complaint is received, it is logged, worked, and monitored at the appropriate level until it is resolved. Complaints can be reported to field engineers, any level of management, or to personnel at AMDAC or the CSC.

Management Information System

The Field Activities Support Tracking (FAST) system serves as the service management and parts management system. FAST tracks field service performance, parts, engineering change orders, and machine history records. All

service activity reports from FEs are fed into this system. Service activity reports contain information on the customer account, type of product serviced, maintenance problem, and corrective action taken. FAST serves as a source database which provides information that is used by engineering to develop a solutions database and to perform product failure analysis.

Service Operations

Customers report service problems by dialing an 800 number which connects them with a central Customer Services Center (CSC) located in Sunnyvale, California (see Figure IV-16). The Customer Services Center is manned by cross-trained field/system engineers. These field or system engineers have training and experience both in hardware and software maintenance. CSC engineers work directly with the customer and attempt to determine the specific source of the problem and, if possible, to solve the problem over the phone. While talking with the customer, the CSC can run remote diagnostics with the problem machine and check the solutions database for responses to similar problems. Over 60% of the problem calls received do not involve Amdahl equipment and are the result of malfunctions by other manufacturers' products connected to the Amdahl processor.

If the problem cannot be resolved, the CSC will access the customer's file and notify the appropriate FE of the problem via a telephone pager. The FE can download the trouble call information, via a modem link, to a laptop

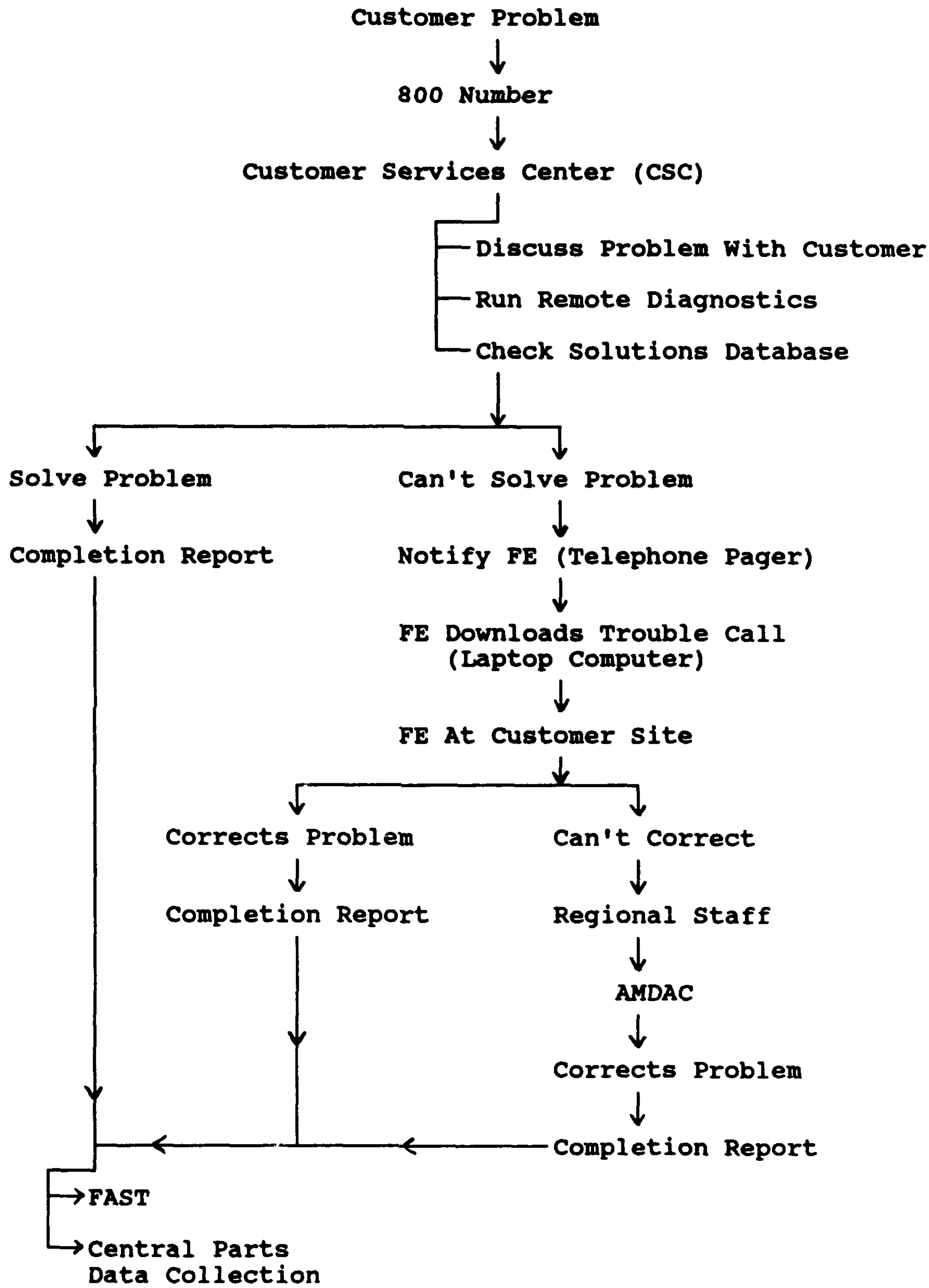


Figure IV-16. Service Operations.

computer and can print out a hard copy utilizing a portable printer. The CSC will also provide any diagnostics results they have received and will often suggest or order parts for the FE. When the FE arrives at the customer site he performs the necessary repairs and provides a completion report back to the CSC via FAST. Parts usage is reported via telephone to the Central Parts Data Collection Department in Sunnyvale which records parts usage, initiates replenishment orders, and updates system/product configuration. If an FE experiences difficulty in performing a repair, two problem escalation routes are available. Amdahl's problem escalation support staff are designated based on increased levels of experience and training: second and third, with third being the higher of the two. Each region has FEs that function as second level staff and are available to perform as on-site advisors. At the corporate level, the Amdahl Diagnostic Assistance Center (AMDAC) is staffed by second and third level staff who can provide assistance via telephone and electronic computer links. Many of the field engineers assigned to AMDAC have spent a one to two year tour in the engineering function. The AMDAC staff is available 24 hours a day to support local field personnel in diagnosis and repair.

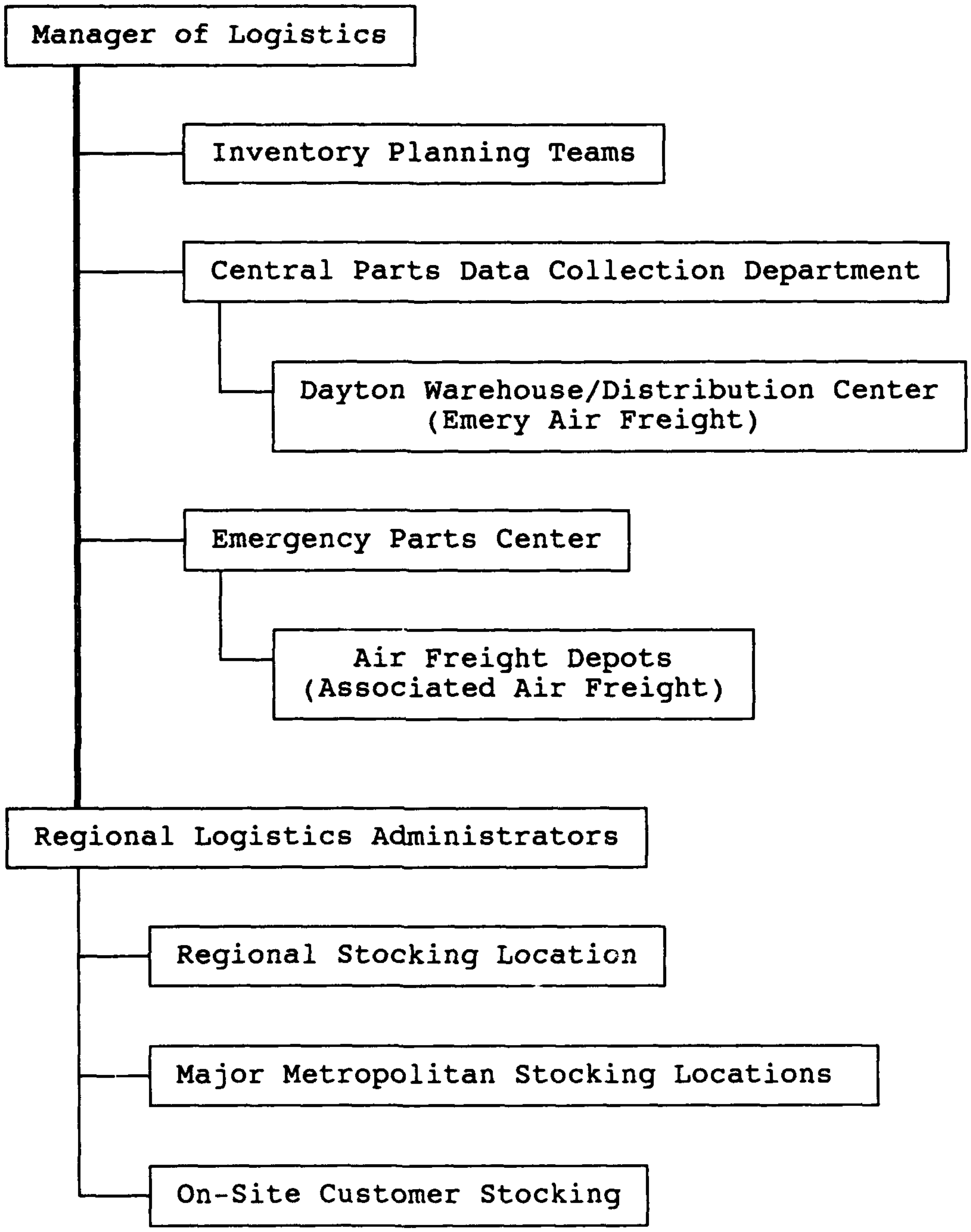
Service Parts Management Network

As previously mentioned, Amdahl's major product lines are processors--mainframe computers. Parts support for one system can run as high as $1 million--the master parts list

consists of 457 pages and contains over 8,600 parts. At Sunnyvale, the Manager of Logistics is responsible for centralized inventory planning, management, and control which is performed by inventory planning teams composed of representatives from engineering, parts management, and customer service. Spare parts are sourced from both Amdahl and Fujitsu manufacturing operations. Parts requirements are initially forecast utilizing engineering reliability estimates based on extensive development and production testing. Historical records of failure data, collected from the FAST system (which also tracks inventory location), are used to revise initial forecasts.

The inventory planning teams also determine the level of repair for parts. For parts designated as reworkable, Customer Services contracts with the corporate manufacturing organization for parts rework. FEs return reworkable parts to the servicing parts stocking location. Depending on the part type, logistics personnel ship the parts to one of two manufacturing facilities located in Sunnyvale and Santa Clara, California. When received, parts are immediately reworked and shipped to the national parts warehouse for restocking.

The utilization of rapid transportation and the stocking of high failure items close to the point of need characterize the Amdahl parts management system which is outlined in Figure IV-17. Dayton, Ohio serves as the national parts warehouse and distribution center. Emery Air



<u>Figure IV-17</u>. Parts Management System.

Freight manages the center which provides replenishment orders for all lower stocking echelons. In addition to replenishment stock, the Dayton inventory contains high dollar, low failure parts. Spare parts depots are strategically located throughout the United States; their geographic locations are based on installed product density. These depots, know as Air Freight Depots, are managed by Associated Air Freight and provide support for emergency orders--two-hour part delivery is the goal. The operations at the Air Freight Depots and at the Dayton distribution center are contract operations and are not staffed by Amdahl personnel; inventory items, inventory levels, and orders (both emergency and replenishment) are monitored and controlled by the staff of the Manager of Logistics in Sunnyvale. A portion of the staff, the Emergency Parts Center, coordinates the shipment of emergency orders from the Air Freight Depots. Replenishment orders are based on a use one, get one philosophy and are initiated by the Central Parts Data Collection Department upon demand.

In addition to the depots and the Dayton location, parts are stocked at regional headquarters, in major metropolitan locations (such as Atlanta or Chicago), and at customer sites. Some minor parts, such as spare fuses or circuit protection cards, are stored in the mainframe itself --field engineers do not carry spare parts kits. High failure, high use parts are stocked close to the customer;

stocking locations remote from the customer stock lower failure, higher dollar parts. Within a region, Regional Logistics Administrators also ship parts from one location to another as required. Annually, a 100 percent physical inventory is performed at all stocking locations.

Summary

Amdahl operates in a limited segment of the computer market, focusing on mainframe computers using the IBM System/370 software and extensions. The company designs, manufactures, and services large computer systems. Customer service is emphasized throughout the company: the awareness of customers' needs and concerns, constant solicitation of feedback from current and prospective customers, and the development of long-term partnerships with customers. The majority of Amdahl's business is repeat business, a fact the company attributes to its customer service orientation.

Technical support offered by the field service force and rapid response to customer maintenance problems are viewed as competitive necessities. For mainframe users, maintenance troubleshooting has long been a cause for dissatisfaction (Zemke, p. 401). Amdahl has capitalized on this deficiency and has consistently achieved high industry ratings in maintenance support. High product reliability, extensive product testing, and the efforts of multi-functional reliability, availability, and serviceability teams have resulted in improved products that are less likely to fail and, when they do fail, are easier to

maintain. Remote diagnostics, patrol circuity, the centralized Amdahl Diagnostic Assistance Center, and other innovative maintenance techniques have also contributed to these high ratings.

A single management information system tracks all maintenance activities, performance measures, and parts. This system provides information for a variety of management reports, allows engineering to evaluate product performance, feeds information to a solutions database designed to speed the resolution of maintenance problems, and enables logistics personnel to perform parts management and tracking. Parts support relies on stocking high failure items close to the point of use and rapid air transportation of high cost, low failure, and emergency parts.

Customer Services, the field service operations organization, operates as a profit center. In keeping with the customer service focus, field service managers are evaluated not only on traditional cost accounting measures (expenses and revenues) but also on employee satisfaction and customer satisfaction.

Hewlett-Packard Company

Overview

Hewlett-Packard Company (HP) was founded by William Hewlett and David Packard in 1939. Their first product was an electronic test instrument--an audio oscillator--that they produced in a garage. The company has since grown into one of the 50 largest industrial corporations in the United

States and employs approximately 94,000 people worldwide. Headquartered in Palo Alto, California, HP has plants in 25 U.S. cities and research and manufacturing facilities in Europe, Japan, Latin America, Canada, and Southeast Asia. In addition to the 160 sales and support offices in the United States, approximately 315 offices are located in 102 other countries. HP is also one of the top 15 American exporters.

The HP product line consists of over 11,000 items sold in a variety of markets. HP's test and measurement instruments are used in the electronics, telecommunications, aerospace, aircraft, and automotive industries as well as in scientific research applications. In the early 1960s, the company expanded into the fields of medicine and analytical chemistry offering a line of instruments and equipment with applications in the chemical, pharmaceutical, and food industries. Today, a major portion of the company's revenue comes from computers, computer systems, peripheral devices (e.g. printers, plotters, disc drives), and calculators. Each year, more than half of the company's revenue comes from products introduced in the past three years.

Organization

HP believes that customer support must maintain a close tie with marketing and sales. This belief is portrayed in the matrix organizational structure used by HP (Figure IV-18). One organization, Worldwide Customer Support, is responsible for hardware support, software support,

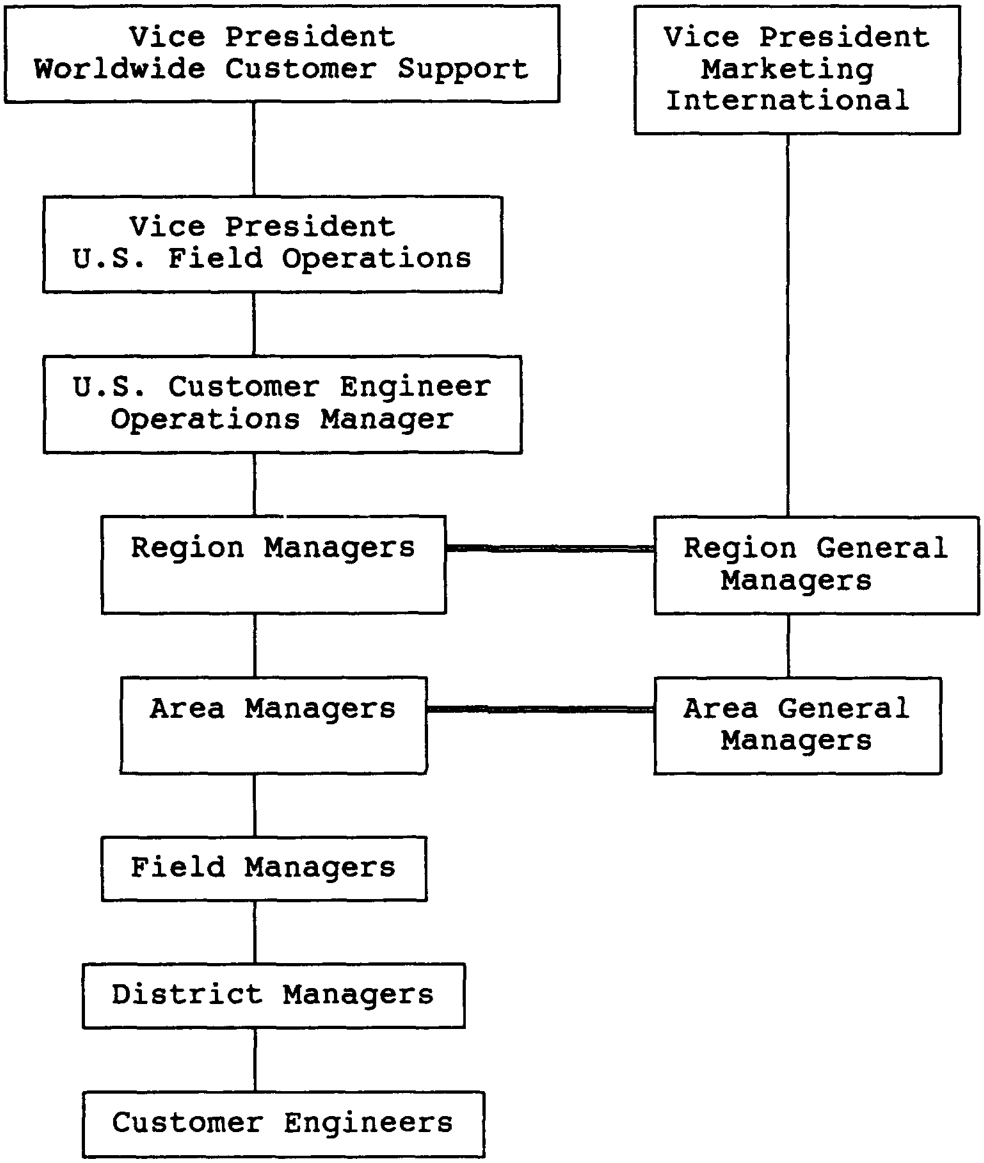


Figure IV-18. Worldwide Customer Support Organization.

education of the customer engineer work force, and the operation of customer response centers. Worldwide Customer Support is headed by a vice president and reporting to him is the Vice President, U.S. Field Operations. For its size, Hewlett-Packard is noted for having few vice presidents and executive positions. The fact that Field Operations is headed by a VP is an indication of how serious HP views customer support and service. The Field Operations organization consists of a U.S. Customer Engineer Operations Manager supported by region (4), area (11), field, and district customer engineer managers. Field managers supervise eight to ten district managers; district managers represent the lowest level of management and typically supervise ten customer engineers (CEs). Field Operations' personnel are considered members of the marketing/sales team. In the early 1970s Field Operations changed from a cost center to a profit center.

Paralleling Worldwide Customer Support is the marketing organization, headed by the Vice President, Marketing International. Marketing personnel utilize consultants, trade journals, and environmental scanning to stay abreast of market conditions. Marketing provides a number of centralized support functions: development of strategic marketing and sales plans, market research and competitive analysis for sales and field service, administrative and personnel support, and logistical support for Field Operations--facility/fleet planning and parts support.

Regional and area general managers and their staffs provide day-to-day administration of parts and coordination of parts needs (e.g. parts forecasts, inventory planning) with their Customer Support counterparts. This dual organization serves to centralize field service support (marketing, personnel, administrative, logistical) functions within marketing, allowing Field Operations' personnel to focus solely on customer service and customer interface.

Strategy

Corporate Strategy/Field Service Strategy

Hewlett-Packard has three sales and customer support groups based on product application: medical products, analytical products (chemical, petrochemical, pharmaceutical, and biotechnology industries), and computer/test and measurement. Of the three, the high-growth area and the key to success in the 1990s is computers and computer networks--test and measurement will be increasingly phased out (Greene, 1990, p. 27). Computer networks often involve products from a variety of manufacturers and customers today demand a single source of support.

In 1989, to position itself for the 1990s, HP supplemented the repair of its own equipment (original equipment manufacturer or OEM service) by offering repair of other manufacturers' products (third party service). HP is committed to providing the finest nationwide (and global) support organization in the industry. To do this,

customer-tailored maintenance plans and advanced tools and techniques, utilizing leading edge technology, have been developed to provide better, faster service.

Competitive Differentiators

A wide variety of hardware maintenance options are offered tailored to the needs of the customer. Four basic levels of service are currently available:

1. Priority plus support: 7 days a week, 24 hours a day.

2. Priority support: standard business hours and evenings, 8:00 am--9:00 pm, Monday--Friday.

3. Next day support: service delivery on the following business day, 8:00 am--5:00 pm, Monday--Friday.

4. Scheduled support: periodic basis (weekly scheduled on-site response whenever customer has products needing repair), designed for less than critical applications.

For customers whose systems availability is crucial, Guaranteed Uptime Support is available providing guaranteed 99% uptime of the core system, response within 4 hours, and coverage 24 hours/day, 7 days/week, 365 days/year. Customers with multi-vendor networks can select HP Network Support Services which feature system design and configuration, installation and relocation, and multi-vendor support capability. Coverage and response time can be varied by product. Advantages are a single point of contact for repair and a single contract and bill.

To service North America, two Response Centers have been established in Santa Clara, California and Atlanta, Georgia. Response Centers complement the local support structure (customer engineers and Area Customer Escalation Centers) by providing telephone assistance and hardware diagnostic support for a wide variety of HP product lines. A part of the Response Center, Helpdesk, offers direct answers to personal computer hardware and software questions.

Highly trained support specialists are located at each center and provide customers and CEs with usage assistance, problem resolution, and remote hardware diagnosis. Response Center specialists have access to a network of support information databases containing customer system history and known, past solutions to problems (solution libraries). Fast-search software using key-word search techniques identify solutions as fast as possible.

If the specialist can't provide a solution from the library, a multi-disciplinary team of engineers is formed at the center to work the customer problem. The teams are organized into groups that reflect customer environments such as: office and administration, planning and control, design and manufacturing. For critical emergencies, special System Interrupt Teams provide crisis management capability. These teams may use advanced simulation systems and expert systems utilizing artificial intelligence technology to assist in developing a solution. Additionally, each

Response Center is equipped with hardware and software for HP products supported from the center. Engineers can reproduce the exact configuration of customer systems to provide a thorough analysis of the problem.

For Hewlett-Packard 3000 systems, remote support capability is available which allows resolution of computer problems often without an on-site visit. HP software programs (resident on the customer's system) are executed from the Response Center via telephone line to examine the customer's system, system log files, and disk error files to determine malfunction. Customer-implemented, temporary procedures are sometimes recommended while a permanent solution is sought. If diagnostics are inconclusive, customer engineers are dispatched. If on-site repair is necessary, preliminary diagnosis provides the right person dispatched with the right parts.

Another feature for HP 3000 systems is Predictive Support software, designed to identify and prevent problems before they occur. This proprietary diagnostic software reads and analyzes system and peripheral error log files and prints a status report of systems function. The customer reviews the status reports and if necessary, uses the electronic data transfer capability provided to send the data to the Response Center for further analysis and diagnosis. This feature allows HP to take corrective action before a problem affects the customer's business. If necessary, an on-site visit will be performed.

HP also believes that its high quality people provide a competitive edge. Annually 1500 to 1800 college and university students are recruited; 70% of these students have technical degrees. In the Southern Region, 98% of the customer engineers have four-year electrical engineering or electrical technologist degrees. Due to its reliance on rapidly changing technology, the company provides its people continuing education opportunities through internal programs as well as advanced-degree programs at various universities.

Another strong selling point for HP service is the assignment of customer engineers to specific customer accounts; most of the time the customer deals with the same person (or persons, each account has a primary and backup CE). This allows CEs to build long-term relationships with customers: CEs know the customer, the customer's schedule, and the customer's business. The development of long-term customer relationships is a company goal of HP.

Product Development/Product Serviceability

In addition to the two Response Centers, each area is served by a Customer Escalation Center whose staff is drawn from the customer engineer ranks. These highly-experienced, product specialists assist customer engineers when difficult problems occur in the field. They also perform another function--serving on design teams for new HP products. Each manufacturing division design team consists of representatives from marketing and sales (design what the customer wants to buy), research and development (design in

Second Harmonic Generation and Sum Frequency Generation in Optical Systems

John D. Bierlein
Du Pont
Experimental Station
Central Research & Development
PO Box 80356
Wilmington, Delaware 19880-0356

Optical waveguides offer potentially significant advantages to bulk stals for efficient second harmonic generation from relatively low power rces because the fundamental optical beam can be tightly confined over interaction lengths. However, since channel waveguides must be used to eve this confinement, phase matching becomes a severe problem. ause the channel orientation is predefined, birefringence angle tuning, h is commonly used with bulk crystals, cannot be used and temperature g, when it can be used, usually requires precise temperature control. Also, the effective propagation constants depend on guide geometry, the guide dimensions must be tightly controlled over the entire optical path h. Although guided second harmonic generation has been observed in rm channel waveguides using both $LiNbO_3$ and $KTiOPO_4$ normalized ersion efficiencies have not exceeded about 5%/W-cm^2 and considerable le-to-sample variation in efficiency and/or phase matching temperature is non.

Several techniques have been demonstrated that can improve overall ncy and ease the phase matching problem. These include coupling en a guided fundamental mode and a radiation second harmonic mode kov radiation), various quasi phase matching (QPM) schemes using both uous and segmented channel waveguides, a new balanced phase ng (BPM) process using segmented waveguides and external cavity uide resonators. In addition to improved efficiency, the guide structure in e QPM and BPM schemes can also be designed to significantly improve ide fabrication tolerances.

The Cerenkov radiation scheme eases the phase matching problem but oupling is difficult and special output beam shaping is required. High ion efficiencies have been demonstrated in $LiNbO_3$, $LiTaO_3$ and KTP PM and in KTP using BPM. For QPM structures, normalized conversion ies are in the 50% / W-cm^2 range for $LiNbO_3$, 100% /W-cm^2 for $LiTaO_3$ 00%/W-cm^2 for KTP. Waveguide fabrication processes have been d to permit phase matched interaction lengths in excess of 5 mm which able output powers of greater than 1 mW. For KTP, the QPM guides oduced outputs in excess of 4 mW average power in the 390 nm to 480 tral region from a 100 mW cw source without any evidence of optical

is paper will generally review the various structures and will then give esults using KTP. Finally, some of the practical limitations of coupling waveguides and of stabilizing the diode against feedback will be d.

reliability and functionality), and customer service (design for serviceability). CEs from the Customer Escalation Centers participate in design planning and design reviews and serve as maintenance advocates.

Before manufacturing can release a new product, a product support plan is required. This plan addresses such support areas as recommended spares, CE training requirements, level of repair, and provides a general maintenance concept and plan. Product support plans are generally written by customer engineers who are on loan to the manufacturing division. Support plans are also required for non-HP, or third party products.

Repair Strategy

The decision on where to repair an item is driven by the cost of repair, the technology of the product, and the customer base (number of products). For computers, the focus of repair is the line replaceable item (LRI), which generally equates to a circuit board. Customer engineers perform numerous repairs each day and HP has found that it is more cost effective to remove and replace defective boards and return the defectives to a central repair location. Customer engineers can perform more repairs per day which minimizes customer down time.

HP also offers product mail-in repair service (HP repairs the product and mails it back to the customer) and carry-in repair. Carry-in repair centers are located in

Atlanta, Dallas, Chicago, Paramus N.J. (to serve New York City), Los Angeles, Denver, and San Francisco.

Parts Support

The obsolescence support program consists of "end of support" and "end of assured support." Hewlett-Packard commits to customer support for a minimum of five years after the last production run (end of support) and for most products will provide support for up to five additional years (end of assured support). Beyond the ten year point, for products for which parts can be procured, HP will provide their "best effort." Due to the rapidly changing technology base, 80% of what HP customer engineers support in the field today is no longer currently in production.

Engineering Change Orders

The Worldwide Service File database, containing all service data reported by customer engineers, is reviewed by design engineers and design teams to identify unusual failures. The correction of high failure rates as well as the inclusion of new technologies, improved service procedures, and other product/service improvements are accomplished through engineering updates known as service notes. Service notes are issued by the manufacturing divisions and are classified as informational, personal safety, or reliability/functionality upgrades. Reliability and functionality upgrades that affect parts or components specify the disposition of existing stock: scrap, use until gone, return part for rework, or order new part. When an

upgraded part replaces an existing one, a new part number is assigned, the old part number is flagged in the parts management system, and CEs are instructed to order the new part.

Performance Measures

Hewlett-Packard Company states that profit is the one absolutely essential measure of long-term corporate performance (Hewlett-Packard, 1989, p. 4). Field Operations is a profit center and operates under corporate financial guidance. Managers are assigned financial targets and quotas and are responsible for the profit and loss statement of the organization they manage.

Complementing the financial measures are "business fundamentals" developed to support the overall mission or goal of Field Operations--to be recognized as the number one support organization in the industry. Each manager jointly develops, with his/her manager, a set of manager-specific goals and objectives designed to achieve the general Field Operations' goal. (Hewlett-Packard promotes "management by objective" versus "management by directive" company-wide.) Managers' goals and objectives are documented and then used to develop a set of business fundamentals used to track and control financial and non-financial operations. For example, targets may be established for customer engineer overtime, training expenses, travel costs, or for the number of repairs performed per day. The on-time submittal of CE performance evaluations may be tracked as well as the

inventory hit rate, a measure of local parts availability. Although tracked at the corporate level, customer complaints may also be monitored by a local manager.

Business fundamentals will be similar for all managers--the fundamentals are all tied to and support the same mission statement. For example, in the southeastern area, the business fundamentals of 30 field and district managers are similar to and related to the area manager's business fundamentals in such a way that if lower level managers meet their goals, area goals will be met. Some tailoring of fundamentals based on location, the customer base, service contracts, and equipment does occur. A business fundamentals report is provided monthly by district managers to field managers; upper levels of management (area managers and above) receive quarterly reports.

Customer Engineer Evaluation

Customer engineers are evaluated on a variety of factors: reliability, responsiveness, competence, courtesy, physical appearance. Every job has an official, generic position description. Upon initial hiring and annually thereafter, District Managers meet with each CE to customize or personalize the description based on the territory assigned, the service requirements of the installed equipment base, and the skill level of the customer engineer. For example, various products in the installed base may have different goals for repair based on the type of service contracts selected by customers. The manager and

the CE mutually set goals and objectives. Each quarter progress is reviewed by the manager and the CE. Additionally, District Managers periodically visit customers to assess overall customer service levels and to obtain customer perceptions of CE performance.

Customer Satisfaction

Annually corporate headquarters mails a comprehensive customer satisfaction survey to a statistically significant sample in each geographic area. In addition to the District Managers' periodic visits, district offices segment the customer base and mail mini-surveys to various customer groups throughout the year. Personnel from the Response Centers also conduct telephone customer satisfaction surveys and the marketing group utilizes a variety of techniques to gauge customer satisfaction. In fact, some concern exists within Hewlett-Packard that the customers are burdened with surveys and a move is underway towards a single annual customer satisfaction report card.

Customer Complaints

All HP employees are trained to handle customer complaints. If a customer calls with a complaint, that should be the last call the customer makes. Customers are not given another number to call. If the person who receives the complaint is unable to solve the problem, he or she takes the customer's number, escalates the complaint, and someone (who can resolve the complaint) will return the customer's call.

A customer complaint tracking system (Customer Feedback System) is utilized to provide trend analysis and to determine the root cause of customer problems. For example, a customer called and reported a printer damaged in shipment. The outside of the shipping box appeared perfect but inside the printer was destroyed. A similar case occurred in New Orleans, then Boston, and finally Memphis. To someone in New Orleans, or Boston, these were isolated cases and not a major problem. By looking at this trend, however, a problem was identified. A manufacturing division had changed the way printers were packed in the shipping box. The new packing procedure was defective and the division was able to correct the problem before other printers were shipped.

HP also provides performance reports to their customers containing information such as product failure rates and downtime, product service history, equipment reliability, and maintenance costs. This account information enables the customer to evaluate and objectively measure the performance of the equipment and of the maintenance program.

Information Systems

HP has its own proprietary system for dispatching and tracking maintenance activities (Figure IV-19). Utilizing the Central Call Management Service, customers dial an 800 number to place a service call. Based on the customer's account number, a customer database is accessed which contains a listing of all installed equipment and identifies

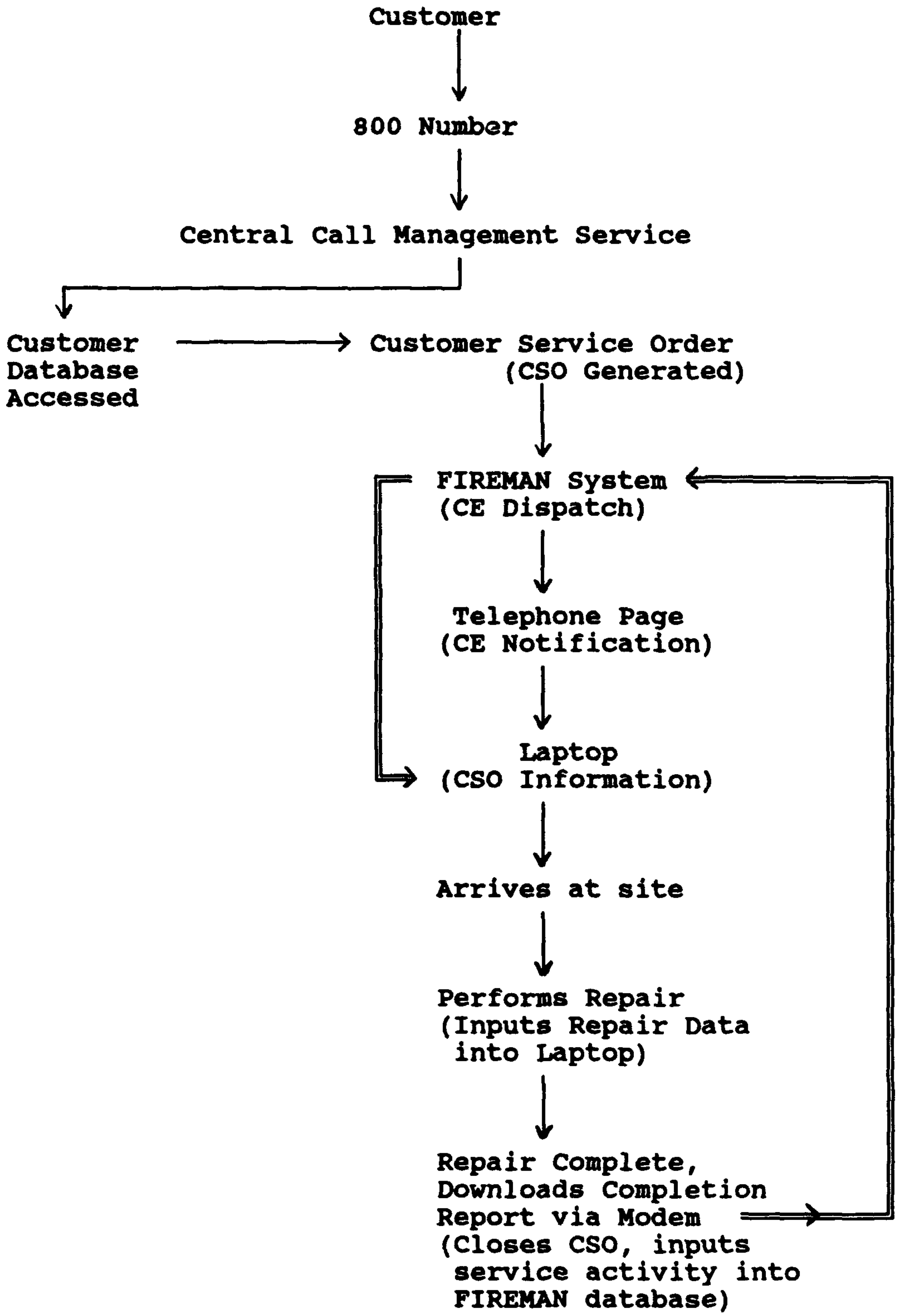


Figure IV-19. Hewlett-Packard Service Operations.

the primary account CE, the backup account CE, any equipment requiring special skills, and if special skills are required, which CE in that geographic area has the necessary training. Another system, FIREMAN (FIeld REsource MANagement), is utilized to contact the appropriate customer engineer through a telephone paging system.

HP customer engineers carry a general purpose laptop computer that is customized via software to run diagnostics, access company databases (through a built-in modem link), provide dispatch information, store maintenance data, and order parts. Open customer service orders (CSOs) are displayed on the laptop screen along with required contract response times.

As the CE progresses through the repair cycle, repair actions (e.g. arrival time, parts used, repair activity time) are input, based on a script, into the laptop's memory. When the repair is completed, the call is closed with Central Call Management and repair data entered into the FIREMAN system by a telephone modem link. An automated program downloads the repair information from the laptop and automatically formats a completion report. If the CE has forgotten to include information or provides bad data (e.g. reports the use of a part not in the inventory or reports a completion time before the dispatch time), the system will report an error and demand an "edit" response.

The completion report repair data (maintained in the FIREMAN system) serves as an input into the Worldwide

Service File. All service activity flows into a Worldwide Service File database which is used to provide various HP organizations with activity reports. For example, parts management personnel and design engineers can review the data to identify if certain components are failing more often than expected. In the marketing area, failure data is used for service agreement pricing review--if the failure rate on a particular product is higher than anticipated, prices may have to be adjusted at the next pricing cycle. All information flows into one database and specially formatted reports are provided automatically or on demand to a variety of corporate organizations. Worldwide Service File data is also available on a subscription basis for customers.

As previously discussed, a problem escalation system provides assistance to customer engineers experiencing problems during service calls. Area Customer Escalation Centers provide access to highly-experienced, product specialists. HP Response Centers provide expanded problem-solving capabilities if necessary.

Service Parts Management

HP stocks approximately 1 million parts to support over 10,000 products. Over 85,000 of these parts are common use--used on two or more products. Parts for HP products are sourced from the HP manufacturing divisions. The move into the third party maintenance market has created some parts sourcing problems for non-HP products. Most companies

will sell parts directly to HP; a few will not. Relationships with fourth party parts providers have been established in those cases where direct purchase is not feasible. A fourth party serves HP as a conduit for logistics support. Service parts and parts rework are centrally managed at Roseville, California.

Parts Performance Measures

A "hit rate" is used as a measure of local parts availability--of all the parts used, how many were available locally (local office or CE kit)? For a customer service order, if 2 out of the 3 parts required were available, no hit was made. The CE must have all 3 of the required parts to fix the system in order to register a hit. At the national warehouse level, delivery time from parts suppliers is monitored. The standards are 95% next day delivery for emergency orders and 95% delivery within 4 days for routine orders. Cycle counting and sample audits are used to monitor parts inventories at all levels; a wall-to-wall inventory is employed if other means fail.

Parts Organization

The service parts organization is portrayed by Figure IV-20. A logistics manager is assigned to each of the 11 geographic areas in the United States. Within each area, high volume parts are stocked at local offices. Additional parts are stocked at Area Logistics Centers which serve as support pools for the offices. Area Logistics Centers stock high cost, low failure-rate, machine-critical parts. For

- Vice President, Marketing, International
  - Roseville, California (Central Stocking Location)
  - Region General Manager
    - Area General Manager
      - Area Logistics Manager
        - Area Logistics Centers
        - Local Offices

Figure IV-20. Service Parts Organization.

example, in the Southeastern Area, there are 28 local offices as well as 4 support pools located in Nashville, Raleigh, Richmond, and Atlanta. Office and support pool stocking locations are based on geographic market size. Roseville, California serves as the primary stocking location for the United States and is the only location that holds safety stock. Safety stock levels are based on usage levels, supplier lead times, and demand variability.

Parts Ordering

Ideally, when a CE is dispatched to perform a repair at a customer site, he has the part. Most HP products have some form of remote diagnostics; by analyzing the problem before a on-site visit, probable solutions can be suggested and required parts dispatched with the engineer. Additionally, CE kits contain high failure-rate, high volume parts tailored for the products supported. If upon arrival at the customer site the CE doesn't have the correct part, an order can be placed directly into the parts inventory system via the laptop computer and a modem link. If there is an urgent need for the part, CEs may use an 800 phone number to contact the Area Logistics Manager who can locate the part within the area or the United States and ship the part directly to the CE Another option is to call the servicing local parts specialist (office level) and have the parts specialist locate and arrange for shipment. For emergency orders, Federal Express is used for next day delivery. If a required part is located at a support pool,

Delta Dash is used with a goal of 4 hours from need to delivery.

Replenishment orders are triggered by CE usage reporting. When a CE completes a repair action, a completion report is entered into the FIREMAN system to close out the customer service order. A portion of the completion report contains parts usage and includes the source location of the part (the CE's kit or, if the part was not available in the kit, the stocking location which provided the part). The FIREMAN system and the parts management system (known as the Service Asset Management System or SAMS) interface allowing SAMS to accumulate parts usage data and generate one-for-one parts orders for all stocking locations. Parts are ordered nightly from Roseville and shipped Federal Express, second-day delivery.

Parts Forecasting

For new products, design teams make a "best guess" for field inventory requirements. Product components are analyzed and compared with historical usage of similar products. The resulting recommended spares list for new products is reviewed by Area Logistics Managers.

The Service Asset Management System provides accumulated usage (failure) data which is utilized by Roseville and Area Logistics Managers to forecast demand for existing parts. The installed product base, the criticality of the part (to system performance), and the type of support desired by the customer (4 hour response versus next day)

are also used by logistics managers to determine inventory stocking levels. CEs can request a review of forecast inventory levels and changes can be made if warranted.

Parts Rework

When a CE reports the use of an item designated as repairable (versus throw-away), an "exchange-old" record is created which must be closed out by the return of the defective part. The repairable part is turned in to the local parts management specialist who ships (United Parcel Service surface) the parts to the rework facility in Roseville, California, daily. If a repairable part is lost, the local office is charged by Roseville for the difference--cost of new part $1000, cost of restored part $250, charge: $750.

Repairable parts returned to Roseville are sent to the defective stock area in the warehouse. Parts are repaired as required--parts with a high demand rate may be immediately scheduled for repair; parts with a low demand may sit for 6 months awaiting repair.

Summary

Hewlett-Packard considers field service an important part of its competitive strategy. Long-term customer relationships are a corporate goal. Customer feedback is considered critical to determining and satisfying market needs. High quality materials and superior workmanship are used to produce highly reliable products. Once a product is delivered to the customer, prompt, efficient service must be

provided to optimize the product's usefulness. By offering superior products designed to satisfy customer needs and by providing outstanding after-sales support, HP believes customer respect and loyalty will be gained and a positive, long-term partnership established.

HP's matrix organization for customer support provides a close working relationship between field operations (service) and marketing/sales (product) personnel. Field service personnel also work closely with HP engineers and manufacturing to ensure serviceability is considered in product design.

To provide outstanding after-sales maintenance, the customer engineer is supported in a number of ways: an extensive parts support organization is managed by marketing, Response Centers and Area Customer Escalation Centers provide assistance with field maintenance problems, remote diagnostics eliminate the need for many on-site visits, a Worldwide Service File database provides rapid access to previous maintenance problems/solutions, the Service Asset Management System provides for automatic replenishment of parts. Additionally, maintenance support packages can be tailored to each customer's individual needs.

General Electric Computer Service

Overview

General Electric Computer Service (GECS) was formed through a merger of GE Integrated Communication Services,

RCA Business Systems and Services, and GE CALMA (CAE/CAD/CAM systems) Customer Support. GECS provides service in three areas: electronic equipment repair and calibration, electronic equipment rental, and computer maintenance. Test and measurement equipment, nuclear and transportation equipment, and satellite communications components are serviced by the repair and calibration function. The equipment rental area manages an inventory of over $100 million and rents products in four broad markets: personal computers, data communications, industrial test equipment, and electronic test equipment. Computer Maintenance Service provides nationwide service on over 1000 products including personal computers, minicomputers, peripherals and local area networks.

GECS provides nationwide, multi-vendor service for electronic-based systems and equipment. The organization consists of approximately 1700 employees, 280 service locations, 3 rental inventory centers, and 23 test instrument services depots. Annual revenues are approximately $220 million.

This case study focuses on the computer maintenance aspects of GECS and future references to GECS in this case will be to computer maintenance functions only. The equipment repair/calibration and equipment rental service areas lie outside the scope of this research.

Organization

The GECS Computer Maintenance Service organization is portrayed in Figure IV-21; national headquarters are located in Atlanta, Georgia. Depot Operations is responsible for overseeing depot repair at the National Depot Repair Center in Dallas, Texas and twenty other nationwide depot repair centers. The primary role of the depots is repair of items shipped directly from customers. Depot services are provided on a repair and return or a swap-out exchange basis for microcomputers, terminals, printers, and peripherals. A secondary function is overflow repair of components for the National Repair Center. Depots also provide repair capability (both end item and component) for major accounts located in their geographic areas--e.g. the Seattle depot provides repair for Boeing; Dallas is assigned the American Airlines' account.

The Warehouse and Distribution function is responsible for all materials planning and manages the National Distribution Center (NDC) located in Norcross (Atlanta), Georgia. The NDC manages the flow of failed and replaced components from the customer site to the appropriate repair facility and back into active inventory. The repair cycle of the National Repair Center (NRC), a component level test and repair facility also located in Norcross, is controlled by the NDC. Information Systems provides networking services to operate and maintain the service management information system (Dispatching And Reporting Transactions

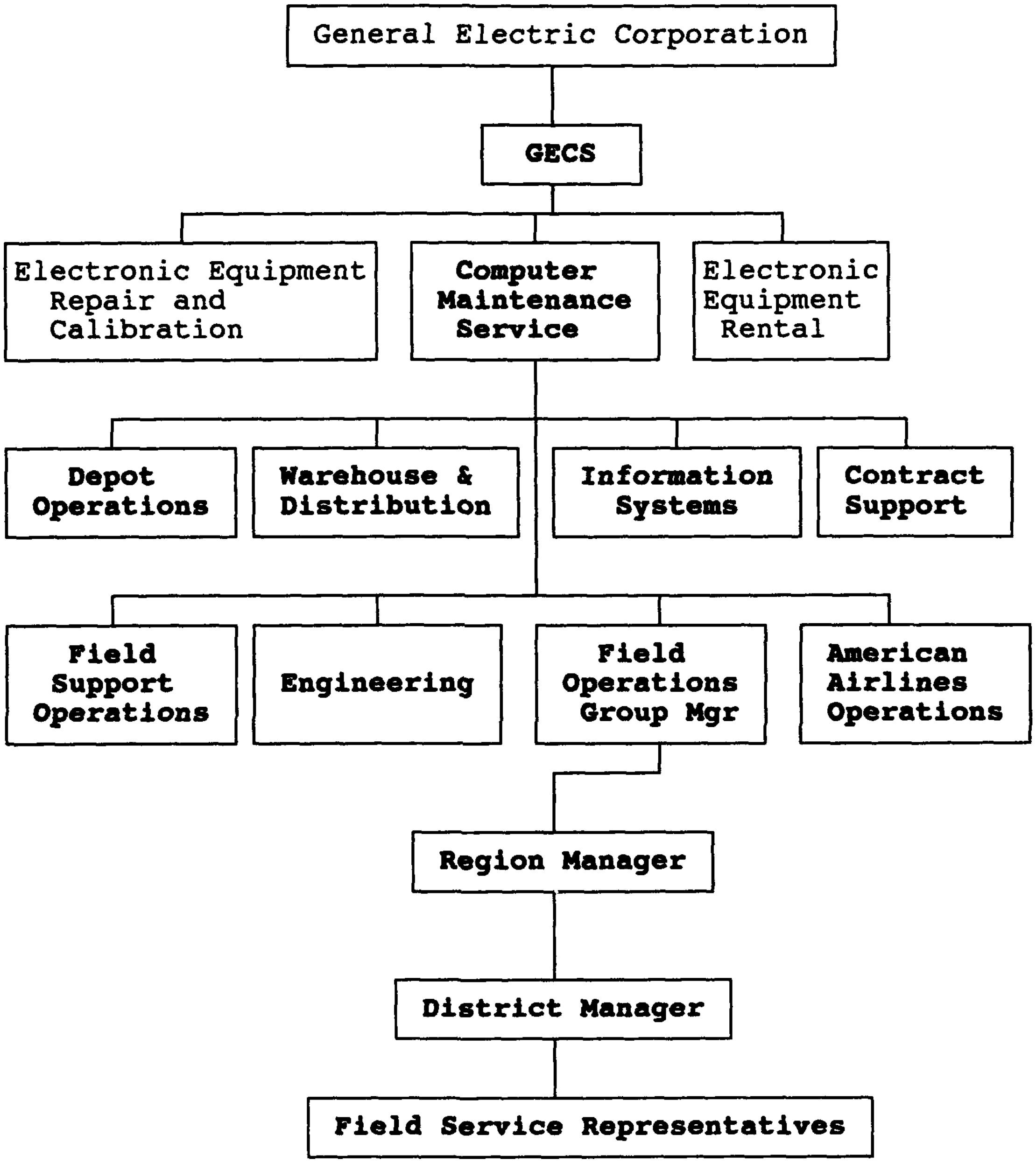


Figure IV-21. GE Computer Service Organization.

or DART system); a nationwide network that tracks all GECS service delivery and inventory transactions.

Contract implementation is performed by the Contract Support function. Contract Support is also responsible for service planning--determining for each customer the service delivery process, training requirements, engineering demands, and all other support factors that must be included in the maintenance contract. Field Support Operations performs call receipt and dispatching of field service representatives (FSRs) through the National Customer Support Center as well as phone assistance and problem diagnosis through the Remote Services function. Engineering is responsible for failure analysis, determination of maintenance methods and procedures, training of field engineers, selection of equipment for customers, and customer consulting services. Due to the size and dollar value of the American Airlines' account, a portion of the Computer Maintenance Service staff is assigned to American Airlines Operations.

Finally, the Field Operations Group consists of a network of 280 service locations organized into 6 geographic regions with over 1000 field engineers. Regional managers are located in Atlanta, Georgia; Cincinnati, Ohio; Dallas, Texas; Los Angeles, California; South Plainfield, New Jersey; and St Louis, Missouri. There are also over 40 district offices located throughout the 6 regions.

GECS also has its own Sales and Marketing group (not shown on chart) which conducts marketing research, develops marketing strategy, and performs sales activities. An important aspect of their job, marketing research, is performed by marketing managers and researchers who focus on the present market place, new technologies, and new product introductions. Information sources include industry publications, computer manufacturers, and inputs from GECS service managers and technicians. Sales and marketing personnel are co-located and work closely with Computer Maintenance Service personnel at the headquarters as well as at Field Operations regional offices.

Strategy

GECS is an independent, third party service provider focusing on Fortune 500 companies that operate in a multi-vendor, multiple location environment. A sampling of current customers includes: NEC, American Airlines, GTE, Avis, TRW, National Semiconductor, and the Union Pacific Railroad. All sales are done through direct selling; no advertising is used. Nationwide maintenance, single-source convenience, and independence (GE doesn't make or sell computer equipment) are stressed as strong selling points.

GECS relies on its past performance and reputation as well as that of its parent company, General Electric, to retain and increase its customer base. General Electric has nearly a century of electronics' service experience with more than 20 years specifically in computer service. GECS

stresses that it is a part of an established, trusted, financially stable company with annual revenues of over $40 billion. Currently GECS is the computer hardware maintenance choice for a majority of the Fortune 100 corporations.

In the past, there were optimum points in a product's life cycle for third party maintainers to enter and exit the service market. Recently, however, customers have demanded changes in the way service is provided. Customers want one number to call for all maintenance problems--both computer hardware and software. Customers now demand complete support of their operating systems to include total system design. In 1990, GECS began offering system design services which include hardware and software recommendations, layout configuration, installation management, and on-going service support.

Customer demands for a single maintenance provider and total system support have resulted in another expansion of the traditional third party service role--the performance of warranty work. For most vendors (e.g. IBM, DEC), GECS has business alliances which facilitate the performance of warranty work. For some vendors there are no alliances and GECS customers have worked with these vendors to assist GECS. Customers inform vendors that GECS is their maintenance provider and if the vendor desires the company's business, GECS will perform all maintenance services, including warranty work, and will be provided with parts,

training, and documentation. Some customers have actually negotiated parts contracts for GECS.

In a 1988 brand performance survey conducted by Data Communications magazine, GECS was rated number one in the following categories:

"The Maintenance Organization Customers Prefer to Do Business With"

"Best Technology"

"Best Price"

"Best Service Organization"

In 1990, an independent survey of over 1700 users of third party computer service rated GE as "most preferred." GECS believes the ability to service broad product lines is essential to single source service and a necessity for national accounts. A centralized structure for service support and inventory control enables delivery of highest quality service at a competitive price. Additionally, GECS is committed to be a total customer service company--dedicated to support the customer with long-term relationships and to form a service partnership with the customer.

Strategic Differentiators

Service/Parts Organization. GECS has invested heavily in a nationwide service organization with over 280 service locations, over 1,000 field service representatives, and a centralized parts management system. The field service force is located in every state and every major metropolitan

area in the United States. The force is managed from six strategically located Region Control Centers. Parts are centrally controlled by the National Distribution Center in Norcross, Georgia which operates around the clock and acts as a parts clearinghouse and distribution center for GECS' nationwide network of parts and supply depots.

Experienced/Highly Trained Technicians. GECS technicians (field service representatives) have on average 9 years of experience with GE, 12.5 years average industry experience, and receive approximately 3 weeks of education/training per year. All technicians and engineers have either college degrees or equivalent industry experience. The experience base of GECS technicians continues to grow with virtually *no turnover in technician* ranks. Four years ago GECS experienced a 13-14% turnover; in 1990 the only turnover experienced (approximately 1%) was due to personnel not meeting standards. This reduced turnover is attributed to increased employee morale which resulted when GECS switched from multiple levels of technician specialization to four levels of "skill sets"--technicians became generalists versus specialists. For example, instead of separate technicians being trained to provide service for personal computers, disk drives, CRT terminals, and modems; repair on these hardware items are now designated as a skill set and one technician does this job. This switch allowed work force flexibility and provided the ability to do more with less technicians. A

side benefit was increased morale--the employees enjoyed the increased challenge of repairing multiple types of hardware. After the initial training expenses, the low turnover rate has reduced hiring and training expenses.

Ninety percent of GECS training is done in-house at a training center located in Atlanta or by training instructors located at each of the regional offices. The engineering training staff in Atlanta examines every type of equipment on contract and physically runs, tests, and may even perform reverse engineering. Failure rate analysis is conducted as well as determination of spare parts requirements--regardless of what the original equipment manufacturer (OEM) offers. Based on the results of this analysis and testing technical guides and training guides are produced to supplement OEM materials; classroom training modules are also developed. Video training is now being used extensively to reduce training costs; the videos also serve as a reference for technicians. In addition to technical training, service technicians receive training in customer satisfaction skills.

Account Managers. When a new account is started, an implementation team is formed to ensure quality, customized service is provided immediately upon the contract start date. The team consists of a team leader, an account manager, and functional experts from service, materials, training, engineering, and contract administration. The team leader is charged with planning and implementation of

the account. Responsibility for the account then passes to the account manager who serves as the liaison between GECS and the customer and as a central contact for all equipment installation requests.

Flexibility. GECS offers a variety of service offerings which can be tailored to each customer's needs. GECS field service representatives can provide corrective repair, preventive maintenance, on-site installation and equipment upgrades, and if required, full-time resident field service representatives with on-site replacement parts inventory and repair capability can be stationed at a customer location. On-call, corrective maintenance can be provided with a variety of response times (e.g. from two hours to two days) and hours of coverage (up to 24 hours a day, 7 days a week, 52 weeks a year). If on-site service is not desired, customers may take or direct ship defective units to the Dallas, Texas centralized depot repair facility or to one of the 20 other nationwide depot repair locations. Depot repair services are provided for microcomputers, terminals, printers, peripherals, and communication components.

Repair Strategy

Through customer surveys, GECS discovered that customers generally do not desire on-site repair; they prefer repair personnel to be in and out quickly. In the early 1980s, if a circuit board in a personal computer were defective, an FSR would run diagnostics down to a chip on

the board and swap the chip. Today, the board is replaced and repaired at a repair facility. If a keyboard has a bad key, the FSR swaps keyboards and leaves. A remove and replace repair strategy is utilized; no component level repair is done in the field. Parts are coded consumable or repairable; FSRs return the repairable parts to the district office where they are consolidated and shipped weekly, via United Parcel Service (UPS), to the National Repair Center (NRC) at Norcross (Atlanta), Georgia.

The NRC is staffed by senior electronic engineers and technicians trained and experienced in performing component level test and repair. The NRC is equipped with automated test equipment, "test bed" systems, and component level repair equipment. For components that are unique to a certain brand or for items that are rights protected, the parts are shipped to the original equipment manufacturer for required maintenance. Engineering changes and upgrades are incorporated when parts are repaired; GECS has agreements with nearly all equipment manufacturers and vendors that allow them to receive modification notices, procedures, and required parts. Components repaired by the NRC or OEM repair facilities are shipped to the National Distribution Center for a quality check, stocking, and eventual reissue. The NDC controls the repair cycle initiating repair when required to meet stocking levels.

Since GE does not manufacture computer equipment, no maintenance feedback loops to an internal product design and

manufacturing function exist as exist in companies that perform manufacturing and field service. A link to product vendors and manufacturers does exist, however. A Technical Support Unit, operating as a function of the GECS Field Operations Group monitors product quality and reliability and provides this information to product vendors. If required, meetings are held with equipment vendors to discuss quality and reliability problems and to develop corrective action programs. GECS Technical Support engineers are also responsible for screening usage reports from the service management information system (known as the Dispatching And Reporting Transactions or DART system) and issuing "lemon" reports to FSRs to identify poor equipment or component performers.

Performance Measures

Until 1987, all key field service management measures were "bottom line," or monetary measurements. In 1987, GE management declared that the company's major commitments were to quality of service and customer satisfaction. In line with these commitments, new performance measures were instituted to supplement the existing monetary measures--quality of service (customer satisfaction), employee management (morale/employee evaluation, appraisals), and asset management (spare parts, diagnostics). Managers are now driven toward service quality since they are evaluated and compensated for quality. Results of these new

performance measures were improved worker morale, increased contract renewals, and expansion of the customer base.

Quality of service/customer satisfaction measurements are generally indicators. For example, if the customer response time (as determined by the maintenance contract) is met a certain percentage of the time, then that percentage of achieving the goal is an indication that the customer will be reasonably satisfied. In the past, a quarterly, random, customer service survey of 25% of the customers was conducted using the mail. Currently the telephone is being used to gauge customer satisfaction. Every month a random sample of 10% of the customers is selected by the district manager; calls are directed at upper level managers and are designed to solicit candid remarks. Customer satisfaction measures and their goals are as follows: mean time to arrive (90%), mean time to complete service (84%), reschedules (13%), and call-backs (4%, return to same location within 7 days regardless of reason).

Employee management measurements consist of turnover rate, productivity measures (applied rates based on work completed versus number of workers), and training hours utilized. Managers at all levels also conduct employee round tables for face-to-face discussion of work force problems and issues. "Skip-level" meetings are also held; these meetings allow employees to meet with one level above their supervisor.

Asset management measures include how many emergency orders a FSR had to make--this reflects how many customers were left "down" (equipment inoperative) and a rush order placed for parts. The return of repairable parts by FSRs is also monitored; parts not returned after 12 calendar days from date of use are considered delinquent. A "negative use" measure is designed to indicate the use of a part that a FSR "never had." This provides an indication of those who perform poor inventory control or who misstate usage. Maintenance contract sales for a geographical area (region/district) drives the authorized inventory level; inventory value cannot exceed 32% of sales.

GECS is a profit center. At the Field Operations Level, cost measures include material, labor (includes overtime and travel expenses), equipment, transportation, and training expenses. These expenses are balanced against service revenue generated. All performance measures are tracked in the Dispatch And Reporting Transaction (DART) system; on-demand and weekly ("week-to-date performance") reports are provided to field service managers.

In addition to field service measurement of customer service quality and customer satisfaction, major account managers (GECS sales personnel) are responsible for polling their customers, at a minimum, once a month. Customers may be contacted by phone or in person. Each major account manager has a certain number of assigned accounts, and is responsible for determining each customer's perception of

service quality. Information from the DART system can provide account managers with a means to explain to customers the actual level of service they are receiving and to put any complaints in perspective. A formal complaint escalation procedure flows through the account manager, region manager, the manager of Field Operations, and finally the head of Computer Maintenance Service.

Information Flow

Communication between field service and sales/marketing is constant and is facilitated by the co-locating of both functions at the Atlanta headquarters and at each of the six geographic regional offices. The manager of Field Operations in Atlanta spends approximately 50% of his work week in the sales marketing arena: assisting marketing in service offering presentations, answering customer calls, and educating the sales force. Additionally, field service representatives are utilized as sources of customer intelligence. Field engineers constantly update the customer database by adding new units purchased by the customer; units that may eventually come under GE service. FSRs don't sell anything, however they do participate in a formal lead program. They provide the lead and point of contact to sales and receive one percent of the gross.

The Dispatching And Reporting Transactions (DART) system is designed to track computer service activities nationwide and around the clock (see Figure IV-22). DART tracks inventory usage, installed equipment, and customer

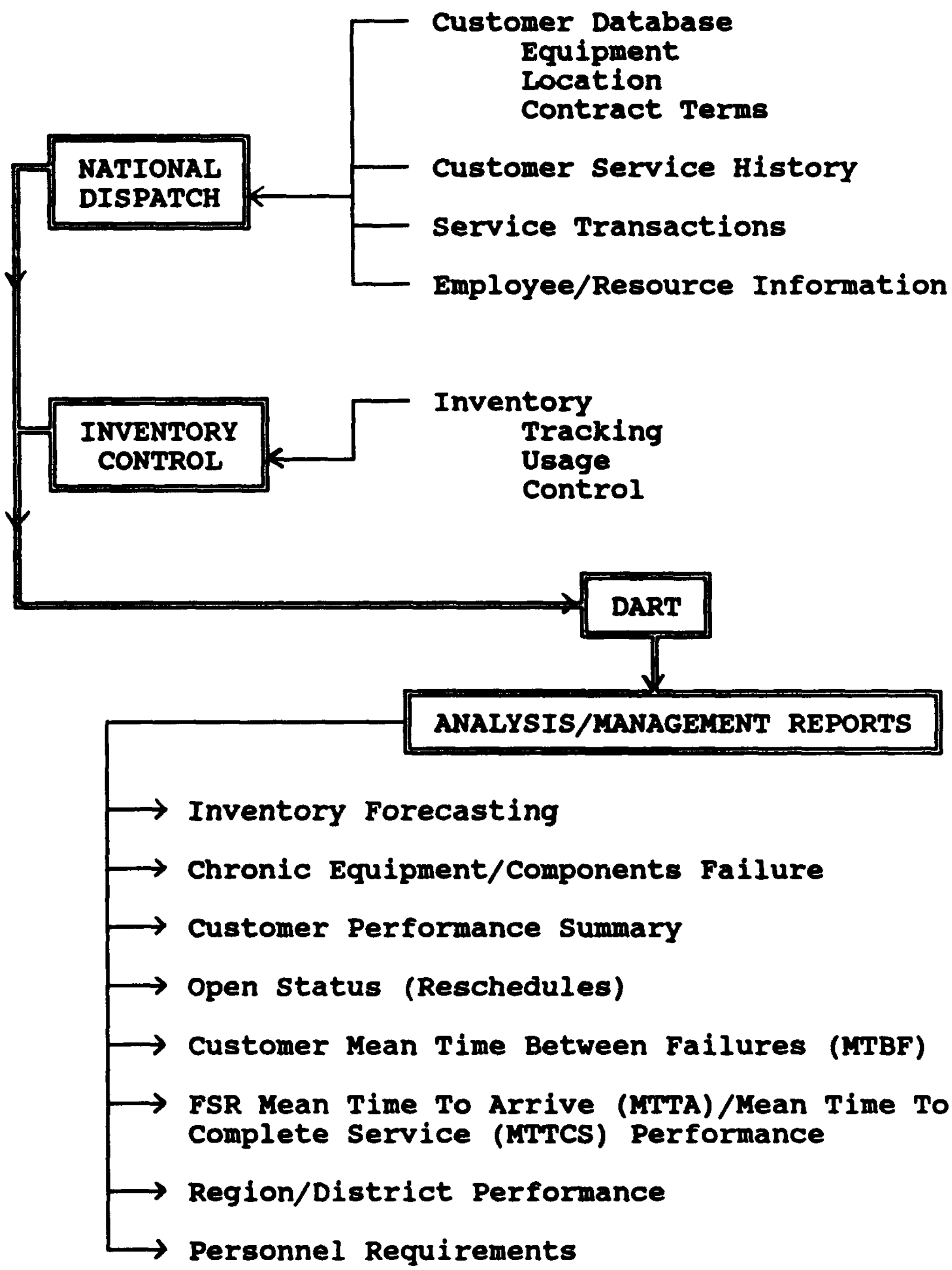


Figure IV-22. Field Service Information System--Dispatching And Reporting Transactions (DART) System.

service histories and provides a variety of management reports as well as a means to forecast parts and personnel levels required. DART consists of two major subsystems: National Dispatch and Inventory Control.

The National Dispatch system logs each service request received by the Customer Support Center (CSC) and automatically assigns the appropriate field service representative to the service call. The DART database contains customer files which contain information on the equipment installed at the user site, response time required, and special service instructions. The service call is tracked from the time the call is received until the maintenance action is completed and the CSC is notified.

The DART Inventory Control system tracks parts and provides GECS' material distribution and repair centers with continuously updated information on inventory levels, spare kits, items in repair, and items returned to inventory. The Inventory Control system maintains local and national inventories at an optimal level and automatically signals the need for inventory replenishment based on usage reports.

Service Operations

When a piece of equipment is experiencing a problem or is down, the customer contacts the GECS customer support system via an "800" number. Personnel at the Customer Support Center review the trouble call characteristics with the customer, collect information on the user site, and enter the data into the DART system. If applicable to the

customer's equipment or equipment configuration, the CSC will contact Remote Services. Remote Services personnel work directly with the customer to define the nature of the problem and to screen out software related problems. Additionally, information from diagnostic diskettes (inserted by the customer and results transmitted by modem link) is analyzed. Often (approximately 28% of the time) Remote Services can advise the customer on actions to take to resolve the problem. If a hardware failure requiring on-site service is identified, the CSC is notified and an FSR must be dispatched.

The CSC dispatches the trouble call to the appropriate FSR (FSR assignment is based on customer/equipment type) within 15 minutes of problem determination. If applicable, Remote Services provides the FSR with failure information and suggested parts.

The FSR is notified of a service call via a telephone pager; a message informs him to telephone his voice mail account to receive service call information. Upon arrival the FSR notifies the CSC and performs the necessary repairs. When the system is restored to normal operation, the FSR presents the customer with a service report which is signed by the customer to acknowledge successful completion of repairs. When repairs are complete, the FSR closes the call by telephoning and reporting service information to the CSC utilizing a script. The script requires such information as customer/equipment identification, FSR, problem description,

parts used, time arrived site, time on site, time departed site, and comments, if any. Key management interest areas are: arrival time, departure time, and parts used. Future plans call for the use of a laptop computer to notify FSRs of service calls and to provide two way communication between the CSC and service representatives. The service operations flow is outlined in Figure IV-23.

A maintenance technical escalation procedure is utilized if an FSR experiences difficulty in repairing a piece of equipment. Hardware product specialists assigned to the Technical Support Unit in Atlanta are available to provide assistance. The Technical Support Unit maintains a detailed technical library containing documentation, diagnostics, schematics, service manuals, and service histories on equipment serviced by GECS. Technical support engineers use these resources plus their extensive service experience in helping FSRs to resolve technical problems. If necessary, the Technical Support Unit will contact GECS depot repair center technicians or OEM product manufacturers for additional assistance.

Service Parts Management

Parts are purchased from either original equipment manufacturers (OEMs) or third party parts vendors. Failed parts returned from field locations are either repaired by the National Repair Center or, in the case of proprietary or unique components, by the OEM's repair facility. All parts flow into the National Distribution Center (NDC) which is

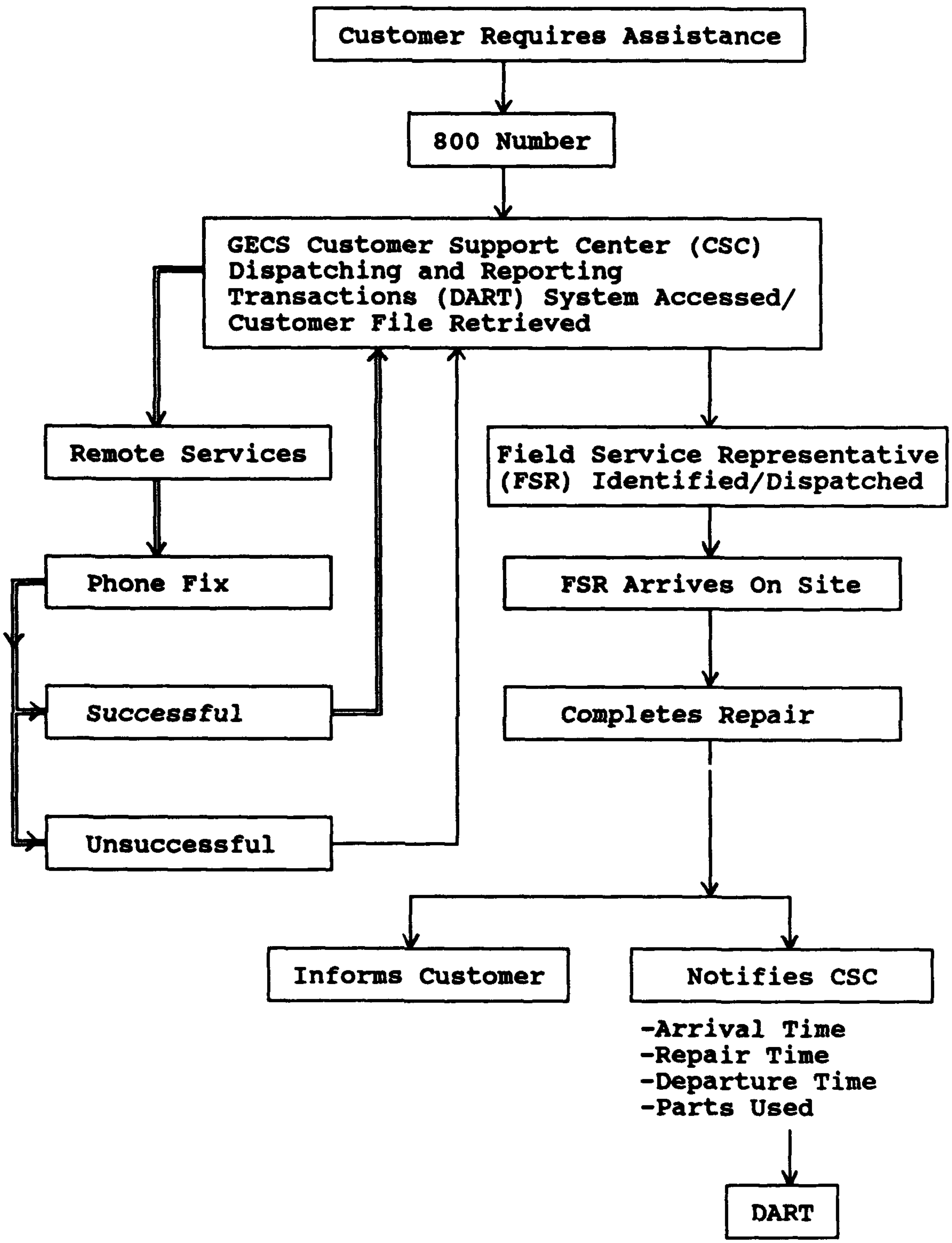


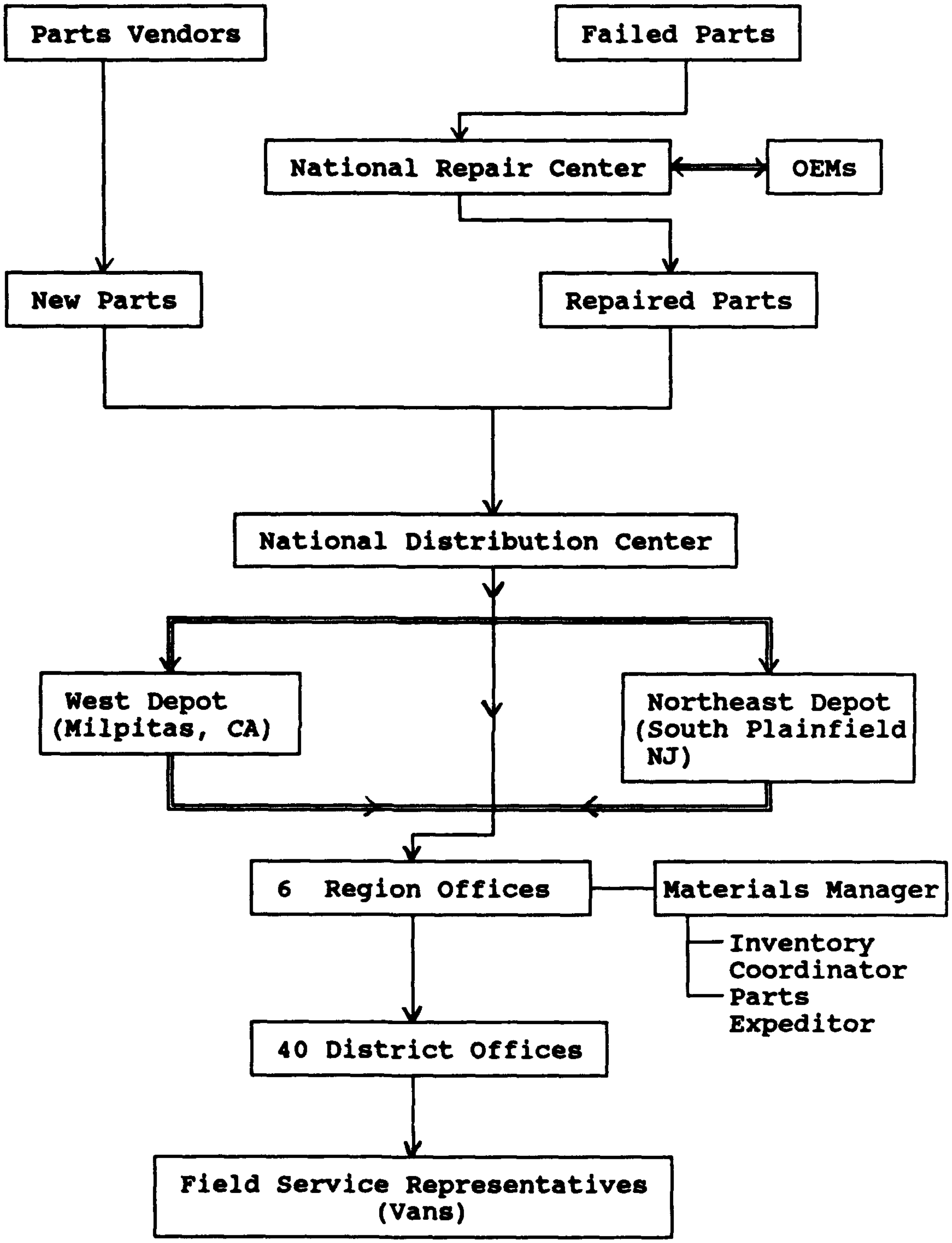
Figure IV-23. GECS Service Operations.

responsible for all parts inventory planning. The NDC supplies parts to all lower stocking echelons (see Figure IV-24).

Two parts depots--the West Depot located in Milpitas, California and the Northeast Depot located in South Plainfield, New Jersey--provide specialized parts support for large, multi-million dollar accounts located within close geographical proximity. For example, the West Depot supports the $10 million Boeing and the $7 million Chevron accounts on the west coast. These two parts depots are co-located with repair depots.

Region and district offices stock low failure, high cost items. Many of these items are delicate and not conducive to constant transport in FSRs' vans. These parts constitute what are known as shared kits; in some high machine density areas extra parts are also stocked in the kits to augment what is carried in the van. Regional offices are staffed with a materials manager, inventory coordinator, and a parts expeditor to oversee inventory management and to assist FSRs in locating and ordering emergency parts when necessary. The lowest stocking echelon is the FSR's van; an average FSR may carry over $100,000 in parts which represents a six week supply of parts. In theory, 90% of the required parts are carried in the van; the other 10% are in the shared kit.

The majority of inventory is stocked at the National Distribution Center in Norcross which supplies both



<u>Figure IV-24</u>. Parts Organization (Computer Hardware Support).

emergency and replenishment orders. For emergency orders (customer equipment is down), the part is shipped directly to the customer site from Norcross utilizing overnight express delivery (Federal Express, Emery Air Freight, or Delta Dash).

Initial stock levels for parts (forecast of new item spares) are based on manufacturer's projected failure data as supplemented by internal GECS engineering and logistical staff analysis. Stock levels for established products are determined by usage analysis obtained from the DART system. Only Norcross carries safety stock. Safety stock is based on vendor delivery performance or repair cycle time plus 6 weeks. Cycle counting procedures are performed quarterly at all stocking locations for 100% of the inventory items; if accuracy is over 98% for a location, the following quarter's count is skipped.

Replenishment orders operate on a use-one, get-one philosophy. FSRs' accounts are filled once a week. Every time an FSR inputs a parts usage transaction into the DART system, a replenishment order is created. If the part was drawn from the region or district stocking location, this is identified by the FSR and a replenishment order is generated for the region or district location. If the part is from the FSR's van stock then, once a week, the FSR receives all replenishment orders which are shipped via United Parcel Service (UPS) from Norcross. Monthly the FSR is provided a transaction report which lists all parts used and all parts

sent--the DART system accomplishes an automatic analysis of usage trends during the ordering process. Additionally the report lists parts that have not been used within the last 6 months and which may now be surplus. If the FSR agrees, the parts are returned to Norcross. Conversely, the FSR may be encouraged to increase the stock level of certain parts. The monthly transaction report notes increased usage levels (projected to use three per month but have recently used six per month) and may recommend that the on-hand quantity be increased. Returns of repairable items are also tracked and closely monitored and reported.

Summary

Five or six years ago, it was difficult for third party maintainers to compete with the *original equipment manufacturers* (OEMs). OEMs didn't want to provide parts and training to third parties since service was a profit-making activity. When customers began operating in a multi-vendor environment and began demanding a single maintenance source, service organizations like GECS became more prominent.

GECS provides uniform service across the country and believes their focus on large, national accounts operating in a multi-vendor environment is a winning strategy. Responsive to customer demand, GECS offered "wall-to-wall" hardware repair capability in 1989, software and local area network maintenance in 1990, and now provides total system design--recommended hardware/software, installation, and on-going service of a customer's entire computer system.

Service is provided through an extensive network of Field Service Representatives supported by a centrally controlled parts distribution system. A single service management information system tracks all major service and inventory functions and provides a variety of reports to manage and control service delivery and inventory. Maintenance services range from flexible on-site support contracts to direct ship of defective units to GECS repair depots.

American Telephone and Telegraph Company Computer Systems

Overview

The American Telephone and Telegraph Company (AT&T) was incorporated in 1885 and for over a century served as the parent company of the Bell System, providing telephone service to virtually everyone in the United States. In 1983, the Bell System was dissolved with AT&T's divesture of the Bell telephone companies. Today AT&T operates worldwide, competing in a variety of high-technology markets while continuing to offer long distance telephone service.

In 1989, AT&T reorganized to provide a better focus on customer needs. A business unit structure was implemented--operating responsibility and decision-making authority were pushed closer to the customer. The overall work force was reduced; staff positions were cut and more employees now sell products and provide service. Currently AT&T is composed of 19 business units that support the company's mission--information movement and management. The principal

U.S. and international markets include consumers, businesses, governments, telecommunications service providers, and electronic equipment manufacturers. At the end of 1989, AT&T had 283,500 employees in 37 countries and revenues of $36.1 billion.

The AT&T Computer Systems business unit provides personal computers, mini-computers, local area networks, networked computing applications, software products, and computer maintenance services. Computer networking is growing nearly 40 percent annually and is predicted to top $17 billion in the United States by 1992. AT&T Computer Systems has targeted some key industries to build a base for future networking business growth: financial services, retail, lodging, health care, education, transportation, and government.

Organization

AT&T Computer Systems is one of 19 business units in AT&T. Each business unit has separate financial objectives and separate business strategies. Computer Systems is responsible for product design and support of AT&T computer systems. The business unit, with headquarters in Morristown, New Jersey, is headed by a President; reporting to the President are three Vice Presidents in charge of Operations, Product Development, and Sales and Service. A National Vice President for Service reports to the Vice President of Sales and Service. A national staff provides

centralized personnel, financial, and administrative support (see Figure IV-25).

The Operations group is responsible for manufacturing, logistics (purchasing and parts management), and training. There is one manufacturing plant (Little Rock) within Computer Systems. Many components used by Computer Systems in both manufacturing and service support are manufactured by other AT&T manufacturing operations or are purchased from other companies. Purchasing brings all the parts together by sourcing internally (Computer Systems), other AT&T plants, or other companies (domestic or overseas). The Material Support Group provides centralized management of computer parts, a function previously performed by Material Management Services, a corporate agency that provided parts management for several business units.

Training for both sales and service personnel is provided by the training function. There are four service training locations: Atlanta, Denver, South Plainfield (New Jersey), and Chicago. Products for hands-on training are available at the training sites. For most products, training is done at all four sites and service personnel (customer engineers or CEs) are sent to the most convenient geographic location. For high capital investment products, training may be held at one site only. For specialized, non-AT&T products, the manufacturer may be utilized to provide training. To minimize training costs and to avoid training every CE on every product supported, CEs are

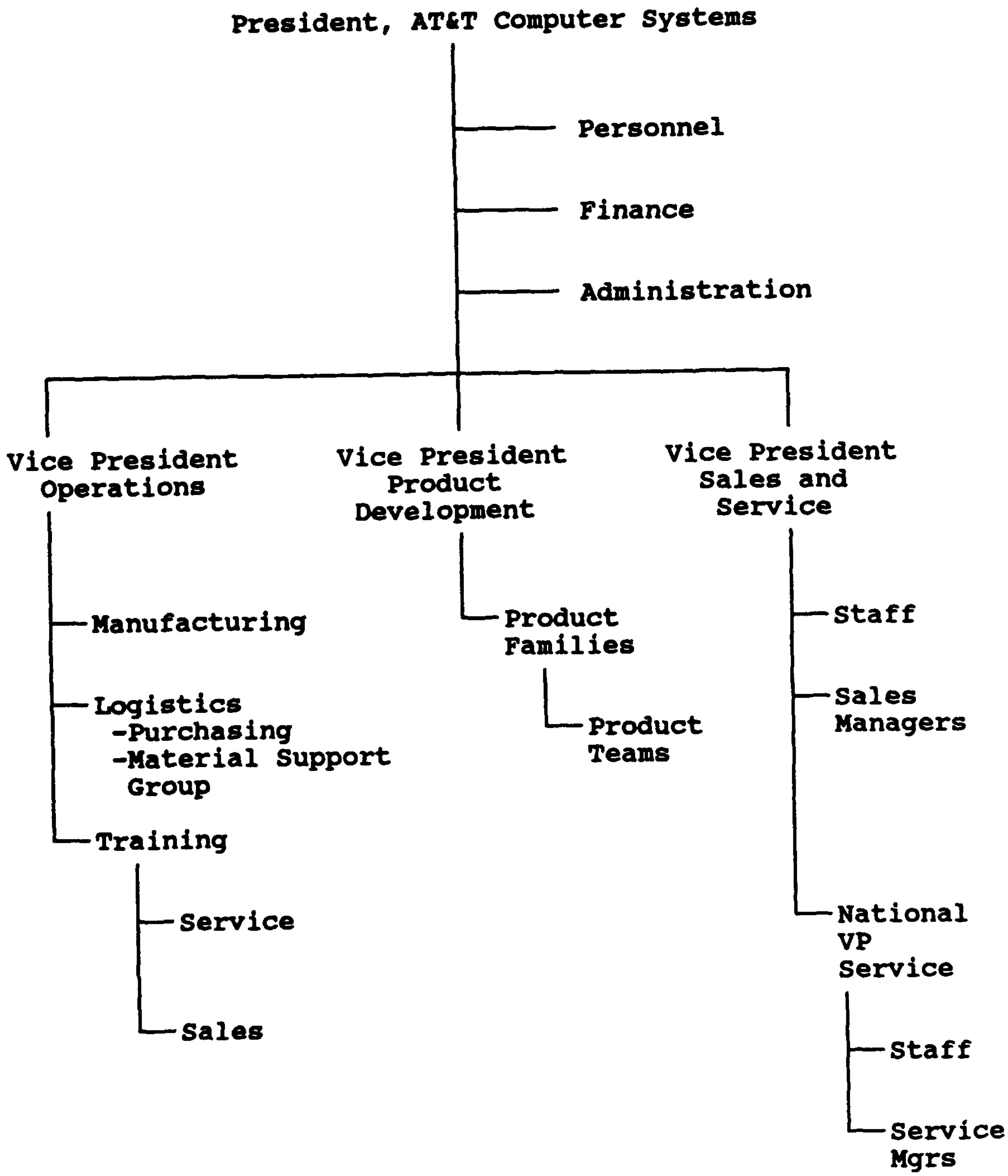


Figure IV-25. AT&T Computer Systems Business Unit.

specialized by customer. The assigned customer engineer and a backup (secondary engineer) are trained to repair the products of assigned customers.

The Product Development organization consists of product teams headed by product development personnel and made up of representatives from manufacturing, design engineering, marketing, and service. Computer Systems groups its products into five product families: high performance systems, mid-range computers, work group stations (entry level systems), networking products, and peripherals. Within each product family, a product team is formed and assigned to each high volume product (e.g. the 6386/25 WGS desk top work station). For lower volume, homogeneous products such as printers, a product team may be responsible for more than one product. Product Development uses a multi-disciplined team approach to develop and refine product design, manufacturing techniques, and product maintainability and supportability.

The Vice President of Sales and Service is responsible for both the sales and service operations. Service operations are a subordinate organization, functioning as a distinct unit and headed by a National Vice President, Service. Sales and service are organized along parallel lines--for every sales executive there is a corresponding service executive that has customer account responsibility for the same geographical territory.

As mentioned, a National Vice President heads the Computer Systems' service function (see Figure IV-26). The Headquarters Support Staff consists of two divisions: Service Product Management and Product Support. Service Product Management provides service product marketing research and develops service pricing strategy. Product Support defines technical training requirements, prepares support standards (to include maintenance and spares strategy), ensures serviceability of products, and identifies required support/service documentation. The Product Support staff maintains a close liaison with the service representatives assigned to product teams.

The service force is managed through Regional Managers (4), District Managers (10), Area Managers (35), and Service Center Managers (165). Over 1400 customer engineers provide service in the United States. The majority of these CEs are based at the service centers, which are located throughout the U.S. in large metropolitan areas with high product density. To provide service to outlying areas, some CEs are stationed in "remote" locations. For example, in South Carolina, a service center is located in Charleston but customer engineers are also stationed in smaller towns such as Florence, Aiken, and Myrtle Beach. These "remote" CEs are managed by and receive support from the nearest geographical service center; in this case, Charleston.

National VP, Service
(Morristown, New Jersey)

- Headquarters Support Staff
  - Service Product Management
  - Product Support
- Regional Managers (4)
  - District Managers (10)
    - Area Managers (35)
      - Service Center Managers (165)
        - Customer Engineers (1400)

Figure IV-26. Computer Systems Service Organization.

Strategy

Each business unit develops its own strategy; however AT&T financial considerations heavily impact strategy. Each business unit must meet a corporate financial plan. The AT&T corporate office develops a financial plan for the Computer Systems business unit. The financial staff of Computer Systems allocates financial goals to Operations, Product Development, and Sales and Service. For services, this translates into a financial commitment called a margin commitment--a measure similar to gross margin but not containing every expense. (For example, some expenses are not pushed down to lower levels, the National Vice President, Service does not carry AT&T Corporate overhead expenses. At the lowest management level, the service center, expenses include salaries, real estate, travel, utilities, motor vehicles, supplies, and spare parts costs.) Margin commitment drives service strategy. AT&T views service as a revenue generator and a profit maker.

Field service marketing research is performed by the Service Product Management staff of the National Vice President, Service. Based on marketing research, the Product Management staff has determined that the customer base demands high quality service consisting of: a service delivery system (including parts) to support the customers' needs; timely response; personalized service; and trained (professional) individuals at all levels, throughout the service delivery process from the call receipt person taking

the trouble call to the customer engineer on site. Computer Systems Service's value statement to the customer is that efficient, effective, and professional services will be provided to the customer to ensure the customer can accomplish his/her mission. Increasingly, service is being stressed in the hardware selling/purchasing process. Customers are interested in technology, product price, and performance; but more and more customers are becoming interested in the service capability offered.

Customers generally desire immediate response--customers want to be sure that when they need a service representative, he or she can respond in a timely basis. For maintenance contracts, the standard response time is 4 hours--4 hours for a location that is within 50 miles of a service center. Locations over 50 miles from a service center have increasingly longer response times based on increased distances and for customer sites over 100 miles from a service center, the response time is 8 hours.

AT&T is currently faced with the service "opportunity" of trying to be "all things to all people." A problem of market definition exists. Strategically, AT&T and Computer Systems' managers are attempting to answer the question: Do we want to be a company that sells maintenance service in large metropolitan areas such as Orlando or Atlanta (where service centers are located) or do we want to be a company that reaches everywhere? AT&T's heritage is that it reaches everywhere. With the current service network and CE

assignments, instead of a standard, national response time, service capability is differentiated based on location: within 50 miles of a service center or beyond 50 miles. The market definition question poses some challenges for the service manager.

Service Differentiators

Flexibility is a key selling point for AT&T computer service. Service offerings can be tailored to whatever the customer desires. AT&T service managers stress that they are better equipped or more willing than competitors to develop a partnership with the customer and to provide unique, customer-defined requirements. For example, AT&T will assign customer-selected CEs, will send service managers to attend regularly scheduled meetings with customer personnel in order to better understand the customer's business, will develop special arrangements for supplying back-up parts to the customer account, and will station service personnel at the customer's work site. AT&T stresses that service offerings and contract terms are a starting point for service to be modified or tailored by customer-specific needs.

To better meet the needs of select customers, an informal customer classification system can be used at the discretion of the local manager. An administrative manager may be appointed to monitor the service accounts of "locally select customers" in a designated territory. There are no specific guidelines; the select customer status may be based

on size of customer account (number of installed machines), the dollar value of the account, the types of critical applications being run on AT&T equipment, or some customer-unique needs such as ongoing training requirements or continuing internal management assistance for complex equipment or systems.

Product Support and Management

Until 1989, little attention was given to serviceability by Product Development and the manufacturing operation--field service was an afterthought. Computer Systems has recently invested significant effort to promote serviceability stressing remote diagnostics capability and common components. Remote diagnostics can decrease the need for service calls and on-site test equipment. Logistics costs can be reduced if, for example, a common power supply can be used in a number of products versus a unique application for each product.

As previously mentioned, product teams are now organized for every product composed of representatives from manufacturing, design, product development (product function), product marketing (customer needs), and services (a service advocate who influences the design and development of the product). This team remains together for the life cycle of the product and is a part of the Product Development organization. Team members solicit feedback from CEs and examine product service records to obtain information on product failures. Product teams are also

responsible for engineering changes which may be suggested by product failure information, technological improvements, or safety concerns.

Product teams develop support standards which specify maintenance requirements, field replaceable units, part numbers, parts stocking locations, training sites, and level of repair. The level of repair decision made by the product support teams determines the product service offering. For some products, on-site repair (removal and replacement of defective components) is the standard service offering. For other products (e.g. personal computers and desk top products) the standard is depot level, or centralized repair --the customer brings the unit into an AT&T facility for repair. For products designated as depot-level repair items, on-site field service is always an option. The contract can be "uplifted" to on-site for an additional premium.

There is no standard life cycle for products. AT&T is very good at introducing products but doesn't do a very good job of stopping support on products. The current service philosophy is to try to maintain a product as long as possible--in some instances, discontinued units, no longer available in the AT&T catalog are still being supported. Some customers have units for which no parts are available, but since they have a contract with AT&T, the customer still expects service. At times, customer engineers have to be very creative.

Repair Strategy

Computer Systems services primarily AT&T products. From a strategic sales view, if a customer indicates a desire to convert from another company's computer products to AT&T products, Computer Systems will manage the change-over process to include interim maintenance on non-AT&T products. Computer Systems has adopted a strategy of not subcontracting repair at the customer's location. When non-AT&T products are serviced, customer engineers, trained by Computer Systems to repair non-AT&T products, perform the maintenance. This approach was chosen in order to have direct control of quality of repair and accountability. A secondary consideration was the Communications Workers of America--a working agreement with the union limits subcontracting of many CE functions and subcontracting with non-union companies could lead to labor disputes. Currently Computer Systems does not consider itself a third party service provider. The capability does exist but it is limited and third party service represents a relatively small (but growing) part of the business.

Besides the national service force, service for AT&T products is also provided by AT&T resellers. Resellers represent an indirect or complementary sales channel and may be either product specialists or software developers. Product specialists sell a variety of products, both AT&T and other brands. Software developers often sell an application package as well as the associated hardware on

which the application operates to provide customers with a "turn-key" solution. Some resellers provide their own service while others market AT&T service. If they perform their own service, resellers can attend AT&T schools (for a fee) and they can purchase an inventory of repair parts. If AT&T maintenance contracts are sold, they are given a commission.

Performance Measures

The National Vice President, Service, utilizes a telephone customer satisfaction survey conducted by an outside research company to determine overall customer satisfaction with installation and maintenance services. Research company representatives work with Computer Systems Service's headquarters personnel to develop the questions. The headquarters staff specifies the type of information desired, negotiates the sample size, manages the survey contract, and receives the survey results. Survey results are sent to the regional and district management levels.

Performance standards for field service managers are developed by the VP, Service and are also dictated by the financial plan. Major performance measures are: the percentage of time the on-time committed installation date is met (based on the customer requested due date); the percentage of time the maintenance on-time commitment is met (the customer engineer arrives at the customer's site at the specified time); and the percentage of time the problem is solved within two hours after arrival at customer site (this

assumes the on-time commitment was met). Additionally, the speed of customer billing (revenue generation) after installation is monitored. Gross margin and inventory value goals are financial targets from the financial department. These measures are tracked via a monthly report at all management levels.

CEs are evaluated twice a year by their managers based on technical performance and customer relations. There are no formal assessment guidelines for first line supervisors. All service managers are expected to make two customer visits a month to discuss service performance and to document those visits. An additional evaluation of service is provided by sales.

The sales force selects a small number of large customers and conducts a customer interview/assessment process. The process is designed to obtain the customer's opinion of the whole range of experience with AT&T Computer Systems: the price of the product, the functionality of the product (Did it work as advertised?), service, and after-market sales support. A questionnaire, consisting of questions with numerical ratings as well as some open-ended questions to allow comments, is hand-delivered to the customer by the sales account manager. The customer is given one to two weeks to complete the questionnaire. The sales account manager then picks up the questionnaire and reviews the results with the customer. Results are passed back to both sales and service managers.

There is no formalized customer complaint procedure. Complaints may be received by any management level up to and including the Vice President, Sales and Service. When received, complaints are investigated, tracked, and resolved by the individual (or their staff) receiving the complaint.

Information Flow

Information Exchange

Sales and service people are co-located and work very closely with one another. A cooperative approach exists due to the nature of doing business--both groups are supporting the same set of customers. Competitively it is advantageous to exchange information concerning service problems or sales opportunities. Sales people want to utilize the CE's knowledge of the customer and build informal relationships with CEs; there are no formal reporting channels.

Service Operations

A Remote Diagnostics Center (RDC) is located in South Plainfield, New Jersey. This center is staffed with several hundred highly skilled technical support engineers and call receipt clerks. An 800 number serves as a customer "hot-line" for product problems. A member of the Call Receipt Group records basic customer information: name, address, account number, equipment type, contract type. After call receipt, a call prompt system, activated using a touch tone phone, directs the caller to the appropriate product engineering group. Select customers (large accounts) are provided codes which allow access directly to a group of

engineers familiar with their products and systems. About 40% of the customer-reported problems are resolved by this Remote Diagnostics Center. The problem is either solved on the phone by instructing the customer to perform certain maintenance tasks or the engineers access the product or system via modem arrangement and correct the problem remotely. (RDC engineers also provide technical assistance to CEs experiencing maintenance problems at customer sites.)

For 60% of the calls, the customer problem cannot be solved and a site visit by a customer engineer is required. Remote Diagnostics Center personnel then direct the call to the appropriate regional Computer System Administrative Center (CSAC) for on-site scheduling. Based on the problem description received from the customer, engineers at the RDC suggest parts for the CE. In 70% of the cases, the correct part is identified; 30% of the time the field engineer must determine the part on site. Overall, 82% of the customers' problems are resolved by phone or on the CEs' initial visit.

CEs are notified via a telephone pager and acknowledge the notification by phone. (A laptop computer or portable terminal is currently under development for the customer engineers.) In addition to notifying the CSAC of call receipt, the CE calls the customer, verifies the problem, and provides an approximate arrival time. Although the customer calls New Jersey and reports the problem, the call from the CE assures the customer that the local representative knows about the problem and is on the way.

This personal contact enhances customer satisfaction. When the engineer finishes the repair, he calls the CSAC via telephone and provides a completion report. A script is utilized and the CE passes the following information: resolution code (a code that describes the maintenance actions performed), time arrived on site, time the trouble was cleared, amount of repair time by equipment type, parts used/part numbers, and amount billed to customer or contract. The service operations flow is outlined in Figure IV-27.

Management Information Systems

The following information systems are used by Computer Systems Service:

1. Delivery Operations Support System (DOSS)--This system tracks install/deinstall information and provides billing information based on equipment location, equipment types, and billing product codes.

2. Business Maintenance Information System (BMIS)--BMIS files are initially created from the billing system (DOSS). BMIS serves as the customer database, containing such information as customer name, address, equipment type, number of equipment items, maintenance activity records, and maintenance contract terms. CE assignments are also included and are used for dispatching by the CSAC. The call receipt clerk inputs trouble (maintenance) reports into BMIS and the CSAC clerk closes out the reports with maintenance data provided by the CE.

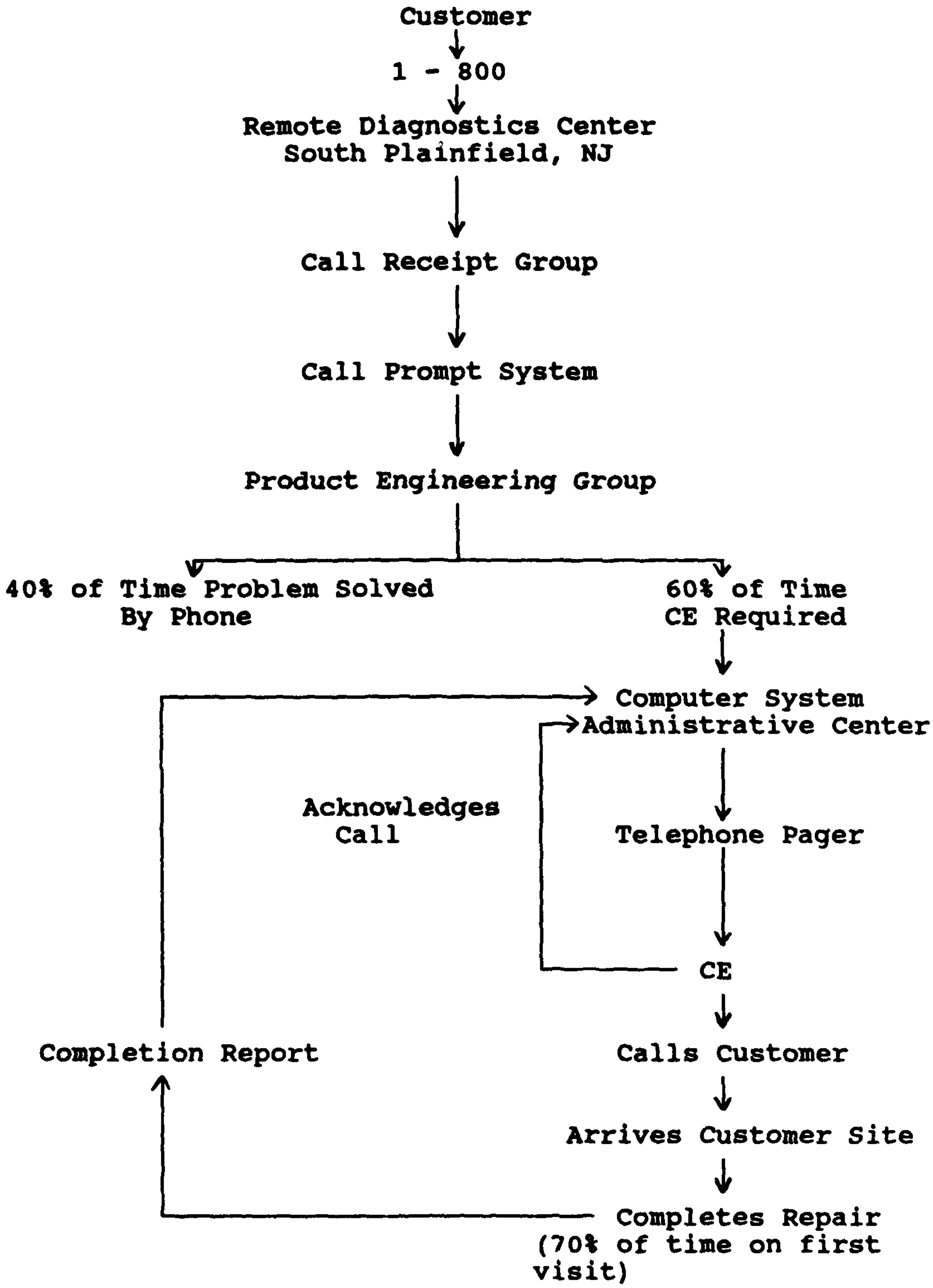


Figure IV-27. Service Operations.

3. Time Reporting System--Customer engineer employee data such as social security number, work location, and wage rate are contained in the Time Reporting System. Hours worked per day are input into this system by clerks in the CSAC (based on CE reports).

4. Stock Status System--The Stock Status system contains part numbers, part descriptions, and quantities on hand at each service center location and in each CE's vehicle kit. Data is input and updated by material handlers at each service center. (The Detailed Parts Inventory Control System or DPICS is a similar system used to track inventory. It is used by material managers at the Memphis Distribution Center and tracks all service center inventories, inventory at the Memphis Distribution Center, and unrepaired stock at the Memphis Repair Center. DPICS is not directly accessible by service center material handlers.)

5. Platform--Platform is software that provides an interface between DOSS, BMIS, the Time Reporting System, and the Stock Status System. Platform ties the various systems together and allows rapid movement from one system to another. Platform does not provide automatic updates between the systems--an update to one system does not automatically update effected data in other systems.

These systems are field service systems and are used for the day-to-day administration of the service process. They are not directly accessible by CEs in the field and

they are not generally used by other business unit functions.

Parts Management

Figure IV-28 depicts the parts management organization and stocking echelons. A limited number of high-failure or system critical (affecting the performance of the product or system) parts are carried in the customer engineer's vehicle or located at the customer site. At the service center level, material handlers are assigned to manage the required amount of selected inventory as close to the customer as possible. They also assist customer engineers in analyzing and optimizing the inventory in vehicles and on-site storage areas (field lockers) and arrange for delivery or pick-up of material when requested. A central warehouse, the Memphis Distribution Center (MDC), supplies parts on an emergency basis and also provides replenishment stock. The Memphis Customer Service Group manages computer parts at the central warehouse. Service parts levels at the MDC are based on recorded field usage plus safety stock; safety stock is based on delivery lead times from part sources. Parts levels for new products are estimated based on parts demand for existing, similar products. The Memphis Customer Service Group orders parts for the MDC through the Operations' purchasing function which sources parts from AT&T plants, original equipment manufacturers (OEMs), and third party vendors.

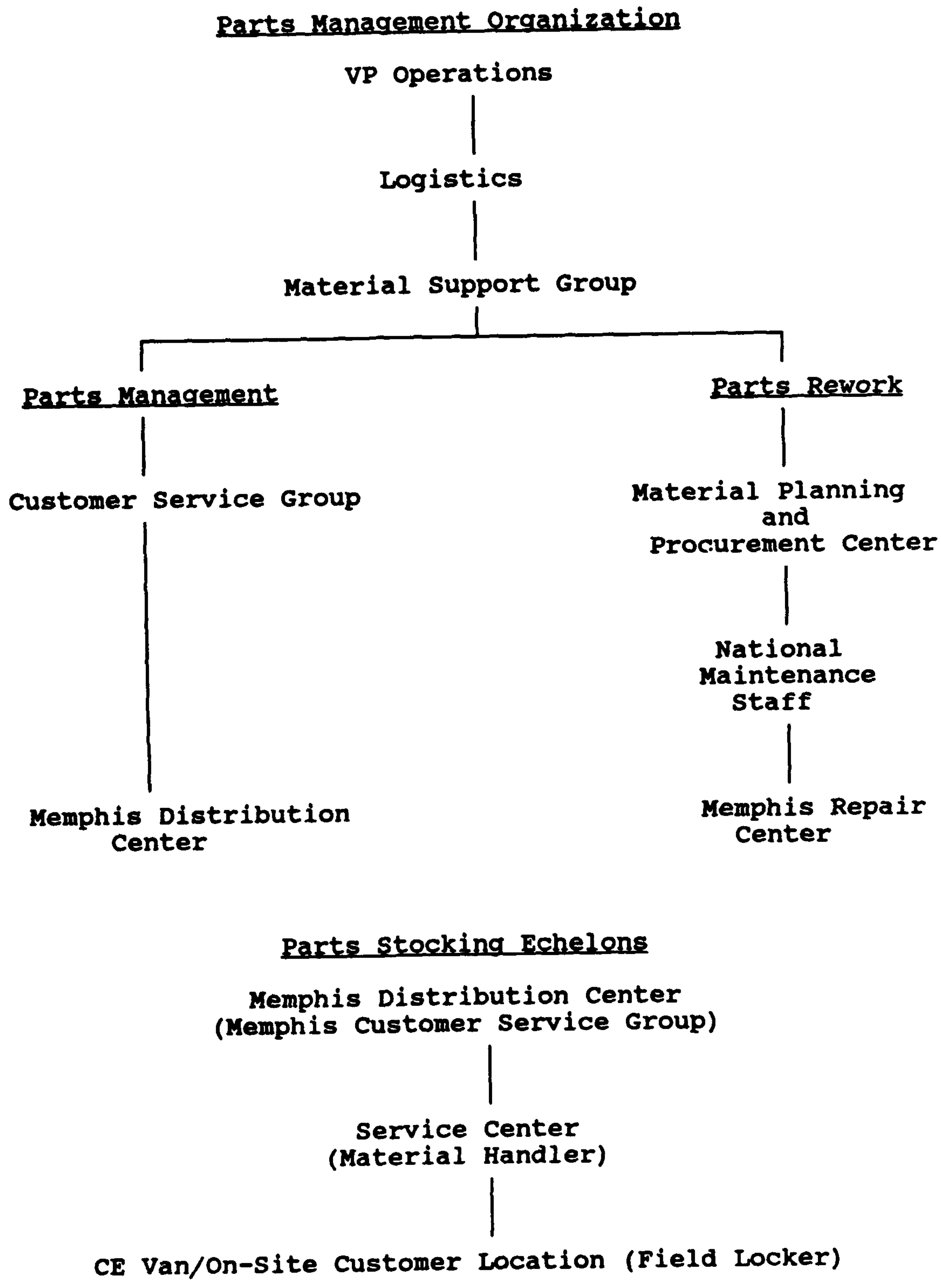


Figure IV-28. Parts Management.

Service center managers set their own stock levels based on the financial plan inventory value targets. A certain dollar value of parts can be kept at a service center; the service center manager can determine the best parts mix based on experience and the customer base.

Replenishment orders for service centers are placed by the material handlers when the on-hand quantity drops below a locally determined minimum target level. Order lot sizes are determined by the service center manager and, like stock levels, are affected by financial plan inventory targets. The service center manager may order up to the stock level or place a smaller order. Replenishment shipments are transported via contract carrier (UPS). Replenishment orders for CEs are generally one-for-one from service center stock.

Parts Search Procedure

If a required part is not available in a CE's vehicle stock or at the on-site location, the material handler utilizes the Stock Status System to review inventories of other local parts locations (vehicles, field lockers) and geographically adjacent service centers. If the part is located, a CE may elect to drive to the parts location and pick up the required part or have the service center's local delivery courier (Hotshot) deliver the part to the site.

If the part is not available in these locations, the material handler contacts the Memphis Customer Service Group at the Memphis Distribution Center. The Memphis Customer

Service Group utilizes the Detailed Parts Inventory Control System (DPICS) to search its inventory as well as all service center inventories and unrepaired stock at the Memphis Repair Center. If the part is in stock, shipment is expedited using overnight air (Federal Express); if the part is in unrepaired stock, repair is expedited. If the part still cannot be located, the National Maintenance Staff at Memphis is contacted. The National Maintenance Staff can authorize parts to be pulled from the next higher assembly or can contact the manufacturing source (AT&T or an outside vendor) and request parts off the manufacturing line (see Figure IV-29, Parts Search Procedure).

Parts Rework

Working closely with product teams, the Material Planning and Procurement Center (MPPC) in Memphis identifies, sets repair strategy for, and manages reworkable parts. CEs turn in reworkable parts to the local service center; the parts are shipped via contract carrier (Consolidated Freight) to Memphis. MPPC performs internal rework (through the Memphis Repair Center) or ships the parts to outside (non-AT&T) repair facilities. An order for repair is generated by the Memphis Customer Service Group and is based on usage and stock levels at Memphis and the service centers.

Summary

Computer hardware maintenance service is provided by AT&T Computer Systems through a nationwide force of over

CE does not have required part.

Service Center Material Handler receives parts request.
Searches:

→ shelf stock in Service Center
→ stock in Sub-Service Center locations (CE vehicles, Field Lockers)
→ geographically adjacent Service Center inventories

If part is not located, contacts:

→ Memphis Customer Service Group (Memphis Distribution Center)

Uses DPICS to search inventories at:

→ Memphis Distribution Center
→ All Service Centers
→ Memphis Repair Center (unrepaired stock, expedite repair)

If part is not located, contacts:

→ National Maintenance Staff

→ Pull from next higher assembly
→ Manufacturing source

Figure IV-29. Parts Search Procedure.

1400 field service engineers. Supplementing the internal service force are AT&T product resellers who elect to stock repair parts and provide maintenance services.

Until 1989, little attention was give to product serviceability and field service. Now products are designed for serviceability and after-sales support is acknowledged as a prerequisite for product sales. Computer Systems services primarily AT&T products. The repair of other vendors' products (third party maintenance) currently represents a small (but growing) portion of Computer Systems' maintenance activity.

Service parts are centrally managed and only three stocking echelons are used: central warehouse (Memphis), service centers (high product density areas, primarily large metropolitan areas), and field engineers (van and/or on-site at customer location). Parts rework is also centralized in Memphis.

Four major challenges face Computer Systems field service operations: (a) union limitations on maintenance subcontracting of non-AT&T products (currently limiting the ability to offer third party maintenance), (b) market definition (offering service to only large metropolitan areas or "everywhere"), (c) the integration of multiple, operator updated field service management systems, and (d) the lack of a product life cycle (complicating product support).

CHAPTER V

CASE STUDY ANALYSIS AND MODEL DEVELOPMENT

Introduction

This chapter consists of five sections. The first section contains a within-case analysis of each of the six cases presented in Chapter IV. Each case is analyzed utilizing the six research questions under study. The second section consists of cross-case analysis, a comparison of the cases to determine similarities and differences among the field service operations studied. The goals of this dissertation were to develop field service management propositions (empirical generalizations) and to construct a model of the field service system. The third and fourth sections contain the field service management propositions and the system model. The final section provides a brief discussion of model development and model evaluation procedures.

Within-Case Analysis

Six electronics companies were selected for study; leading companies were selected to provide insight into "best practice." Case studies for each company were based on information obtained from pre-visit questionnaires, interviews with company personnel, observation, and company documentation. The data collected and presented in the case

studies describe the operation of each company's field service organization. Six research questions formed the framework for data collection and subsequent analysis:

1. How is the field service function organized?

2. What is the field service strategy and how does that strategy contribute to the overall company strategy?

3. What performance criteria, standards, and measures have been set to evaluate field service performance?

4. What service processes make up field service operations?

5. How is the management information system organized within the field service organization and what information interfaces exist with other company functions?

6. What logistical techniques are used to manage service parts?

The within-case analysis begins with detailed case write-ups (presented in Chapter IV) and provides investigators with a means of coping with and organizing the vast amounts of data associated with case study research. This form of analysis also allows researchers to detect the unique patterns of each case before generalizing patterns across cases. Eisenhardt (1989, p. 540) notes that there is no standard format for within-case analysis. The case studies compiled for this research are descriptive in nature; in this section, data for each case is summarized both verbally and via figures and organized by the major subject area of each research question. Cases and their

accompanying summary figures are presented in the following order: National Cash Register (Figure V-1), International Business Machines (Figure V-2), Amdahl Corporation (Figure V-3), Hewlett-Packard Company (Figure V-4), General Electric Computer Service (Figure V-5), and American Telephone and Telegraph Computer Systems (Figure V-6).

National Cash Register

Field Service Organization

National Cash Register (NCR) Corporation is composed of two major functional areas--marketing and manufacturing; the field service organization is a part of the marketing function. The Vice President and Group Executive of the U.S. Marketing Group oversees six geographic divisions and the Customer Services Division (CSD), each headed by a division vice president (VP). Six functional area vice presidents are assigned to each geographic division. The six area vice presidents provide financial, administrative, and special markets' staff support. Additionally, one area vice president, the Area Vice President for the Customer Services Division, serves as the head of field service operations and reports directly to the Division VP with "dotted-line" reporting responsibilities to the Customer Services Division Vice President. CSD provides centralized support, direction, and programs for the dispersed field service organization: spare parts management and distribution, field service engineer training, personnel

support, development of maintenance service plans, and management of internal CSD information systems.

Below the Area VP for CSD, field service operations consists of region directors, district managers, zone managers, field engineer (FE) group leaders, and the field engineer service force. Field service is a profit center; revenues are ultimately incorporated into the division level profit and loss statement. Maintenance support is considered an integral part of product sales and throughout each geographic division, down to the district level, field service personnel are co-located with their marketing counterparts to facilitate the daily exchange of information and close coordination of customer support.

Strategy

NCR Corporation has determined that its customers desire information systems that provide adaptability, flexibility, and dependability. Open, Cooperative Computing (OCC), NCR's long-term product strategy, is a response to the first two demands. OCC provides the capability to add system modules to network configurations and allows different computers, subsystems, and software to operate together. OCC permits customers to modify and upgrade systems over time and allows customers to choose the best business hardware and system applications from a variety of vendor offerings. Dependability is achieved by providing reliable products and responsive maintenance (field) service.

Nationwide maintenance coverage is provided by over 5000 field engineers working out of 400 locations. Customer service options range from full, on-site maintenance provided by NCR to customer maintenance. The difficulty of repairing component level failures in the field necessitated NCR to adopt a remove and repair maintenance strategy--field engineers remove defective circuit boards, replace them with new boards, and return defectives to a repair center for testing and corrective maintenance. This repair strategy, coupled with remote and built-in diagnostics, speeds the repair process at the customer site. Company coverage is supplemented by a network of independent dealers who sell and service NCR products.

Close CSD coordination with manufacturing--CSD field engineers are assigned to every manufacturing facility--insures that serviceability is considered in product design and that accurate, new product spares lists are developed. Parts failure data, field service activity reporting, and in-plant testing and evaluation are also monitored by CSD/manufacturing teams to update recommended spares listings and to develop engineering change orders for equipment modifications.

Field service is important for not only NCR manufactured products but also for non-NCR products. OCC allows customers to choose from multiple vendors. In 1985, to operate in the multi-vendor environment and in response

to customer demands for a single service supplier, NCR offered third party service.

A product life cycle of 5-8 years is used. When a product is dropped from the product line, CSD's general policy is to support the product for an additional 8 years.

Performance Measures

Both accounting and non-accounting performance measures are used. Field service operates as a profit center and is measured using traditional cost/revenue metrics. Marketing and sales provide the source of field service revenue; revenue is dependent on the number and type of maintenance contracts sold. Field service managers manage costs with primary emphasis on overtime and inventory expenses. Additionally, customer satisfaction is measured based on a quarterly survey mailed to approximately 25% of the customer base. A customer report card is also sent to each customer; this report is designed to report to the customer how well CSD has served the customer. Data for the report card is extracted from the Performance Measurement System, a centralized database covering field engineer and equipment performance.

CSD attempts to solve customer complaints at the lowest management level by encouraging customers to work with zone and district managers. However, customers are provided a corporate phone number that may be used if customers have a complaint that they feel should be elevated. The President of NCR has a formalized complaint tracking procedure and a

staff specifically dedicated to solving customer problems and resolving complaints.

Management Information Systems

Three systems support field service operations: the Customer Assignment System, the Central Dispatch System, and the Performance Measurement System. District CSD personnel enter customer account information--equipment type, customer data, contract type, field engineer assignments--into the Customer Assignment System. This account information is formatted into a customer file. The Central Dispatch System performs field engineer notification and dispatch when a trouble call is received. The Performance Measurement System (PMS) is constantly updated by field engineers and serves as a centralized database of field service activities. In addition to being the source of information for the customer report card, this database provides performance statistics on field engineers and equipment to all management levels.

Service Processes

In the United States, five Service Coordination Centers receive customer service requests. A toll-free number connects the customer to one of the five centers. Personnel at the centers access the Customer Assignment System, locate the customer's file, and use the Central Dispatch System to alert the appropriate field engineer. Field engineers are notified via a telephone pager; information on the trouble call can be downloaded from the system by telephone link

into a hand-held terminal. An RF-link (radio) system is currently under development to eliminate the need for telephone paging and access. When the repair is completed, the field engineer passes a completion report, via the hand-held terminal, to the Performance Measurement System (PMS) and notifies the local parts specialist/clerk of parts usage.

If a field engineer experiences difficulty in performing a repair, support is available from two sources: field engineer group leaders and district level 2 support. Group leaders are field engineers chosen for advanced technical expertise; they may discuss the problem on the phone or may go directly to the customer's location and provide on-site assistance. Level 2 support personnel run remote diagnostics (when the equipment is so configured), suggest on-site diagnostics, access the PMS to check product failure history to detect similar problems and their solutions, and interface directly with manufacturing and engineering sources if additional assistance is necessary.

Service Parts Management

A Worldwide Service Parts Center, operated by CSD and located in Peachtree City, Georgia, serves as a centralized service parts management and distribution operation. The center provides 24 hours per day/7 days per week parts service and stocks both NCR parts as well as third party parts. WSPC item managers determine forecasts for parts families utilizing historical demand, exponential smoothing,

double exponential smoothing, and moving average. Forecasts for new parts are determined by manufacturing plants based on the number of units in service, mean time between failure (estimated) and historical demand patterns for similar products. For the WSPC, parts' order timing and order quantity are driven by an economic order quantity (EOQ) based, time phased order point (TPOP) system. All inventory, regardless of location, is carried on the WSPC books and is tracked by the WSPC. An inventory tracking system (Field Engineering Inventory Management System) utilizing bar coding and constantly updated by on-line, real-time processing of inventory transactions (conducted by parts specialists/clerks) is used to track inventory throughout the system. Reworkable parts are returned to various rework facilities: seven repair depots, two finished goods service centers, and a repair center located at the WSPC. The repair schedule for reworkable parts is driven by the TPOP schedule.

Parts are stocked at the WSPC, district offices, and zone offices. Field engineers also carry a stock of high failure parts for their assigned equipment types. Area and regional inventory managers provide guidelines (based on inventory usage analysis) for stocking levels below the WSPC. CSD district managers, responsible for inventory cost management, tailor these stocking guidelines and determine the reorder timing and lot sizing of district and zone replenishment orders. Replenishment orders for field

engineer stocks are based on one-used, one-ordered and are placed by parts personnel. Parts replenishment orders are shipped via truck; emergency orders are shipped Federal Express (overnight) or Delta Dash/Eastern Sprint services if overnight will not suffice.

International Business Machines

Field Service Organization

Prior to a 1991 reorganization, the National Service Division or NSD, was responsible for providing after-market maintenance support for IBM customers. A goal of the reorganization of NSD, its placement under marketing, and the establishment of trading areas was to facilitate the exchange of information between functional areas at the branch level. Maintenance, marketing, and professional services (consulting) personnel are now co-located in the same offices and interface and exchange information on a daily basis. This facilitates a team approach to customer needs; a cross-functional team that offers a complete, "packaged" solution to customer problems.

Heading this team is an IBM Senior Vice President and General Manager in charge of the U.S. Marketing and Services organization. Marketing and Services consists of 8 marketing areas and 64 trading areas; each is headed by a general manager. At the marketing area level, an Area Manager for Services supports field service operations by providing technical support and by managing an Area Communications Center. Three branch managers, one of which

Field Service Organization
- -Located within marketing group
- -Dual reporting chain for field service operations
  - -Direct to Marketing Division Vice President (VP)
  - -Dotted-line to Customer Service Division (CSD) VP
- -Area VP for CSD assigned to each geographical marketing division
  - -Heads field service operations
  - -Supported by region directors, district managers, zone managers, field engineer group leaders, field engineer (FE) work force
- -Centralized field service support provided by CSD
  - -Spare parts management and distribution
  - -Training
  - -Personnel support
  - -Development of maintenance service plans
  - -Management of information systems
- -Field service managers co-located with marketing representatives
- -Profit center

Strategy
- -Maintenance support considered integral to product sales
  - -Customer-tailored maintenance contracts
    - -On-site remove and repair maintenance strategy
  - -Field service force supplemented by NCR product dealers who offer service
- -Third party maintenance offering driven by NCR Open, Cooperative Computing (OCC) product strategy
  - -Provided by NCR field engineers
- -Field service closely tied to manufacturing
  - -Field engineers assigned to each manufacturing facility
    - -Serviceability advocates
    - -Develop and refine spare parts listings
    - -Participate in engineering change order process
- -Product life cycle 5-8 years
  - -Will provide support for up to 8 additional years
- -Diagnostics
  - -Remote/built-in

Figure V-1. National Cash Register Within-Case Analysis Summary.

<u>Performance Measures</u>
- -Traditional accounting expense/revenue
  - -Revenue generated dependent on type and number of maintenance contracts
  - -Expenses managed by field service managers
    - -Emphasis on controlling overtime and inventory costs
- -Customer satisfaction measured through quarterly surveys (mailed)
- -Customer report card
  - -Provides NCR performance record to customer
  - -Source: Performance Measurement System data
- -Formal customer complaint and tracking procedure
  - -Corporate phone number provided to customers
  - -NCR president has a customer complaint staff

<u>Management Information Systems</u>
- -Customer Assignment System
  - -Customer account information/customer files
- -Central Dispatch System
  - -Field engineer (FE) notification: telephone pager
  - -FE access: hand-held terminal with modem link
- -Performance Measurement System
  - -Database of field service activity
  - -FE access: hand-held terminal with modem link
  - -Information used by field service managers and all areas of CSD

<u>Service Processes</u>
- -Toll-free number for customer
- -Calls received by one of five U.S. Service Coordination Centers (SCC)
  - -Central Dispatch System used to notify FE
- -Field engineer
  - -Hand-held terminal
  - -Accesses:
    - -Central Dispatch System for trouble call information
    - -Performance Measurement System to file completion report
- -FE notifies parts personnel of parts usage

<u>Figure V-1</u>. <u>Continued</u>

<u>Service Processes (Continued)</u>

- -Problem escalation
    - -FE group leaders
        - -Telephone
        - -On-site
    - -Level 2
        - -Telephone
        - -Remote diagnostics
        - -Manufacturing/engineering contacts

<u>Service Parts Management</u>

- -Centralized parts management and distribution
    - -Worldwide Service Parts Center (WSPC), Peachtree City, Georgia
        - -Economic order quantity(EOQ)/time phased order point (TPOP) ordering system
        - -Inventory tracking system (Field Engineering Inventory Management System)
- -Stocking echelons
    - -WSPC
    - -District offices
    - -Zone offices
    - -FE kits
- -Joint management of parts below WSPC
    - -CSD district manager
        - -Responsible for inventory cost
        - -Determines timing and lot sizing of replenishment orders
            - -Generally one-for-one FE replenishment
    - -Inventory managers
        - -Guidelines for stocking levels
- -Forecasting
    - -Existing products
        - -WSPC item managers
        - -Parts families
            - -Historical demand
            - -Exponential smoothing, moving average
    - -New items
        - -Manufacturing plants
        - -Estimated
            - -Comparison with existing parts usage
            - -Mean time between failure
            - -Number of units in service

<u>Figure V-1</u>. <u>Continued</u>

Service Parts Management (Continued)

- -Transportation
    - -Replenishment
        - -Truck (commercial carrier)
    - Emergency
        - -Federal Express (overnight)
        - -Delta Dash/Eastern Sprint
- -Rework
    - -Seven repair depots
    - -Two finished goods service centers
    - -WSPC repair center
    - -Schedule controlled by WSPC TPOP system

Figure V-1. Continued

is responsible for service operations (field service), are assigned to each trading area. Below the Service Operations Branch Manager are field managers and the customer engineer (CE) work force. U.S. Marketing and Services provides centralized field service support for training, communications, information processing, and parts support. Service Operations is a profit center.

Strategy

In 1985, IBM developed a strategy to become leaner, more efficient, and market driven. Over the years, to implement this strategy, IBM has eliminated staff positions and retrained personnel into areas involved with developing and marketing responses to customer needs or servicing customer problems. Decision making and accountability have been pushed closer to the customer and a service partnership between IBM and the customer is stressed. For field service, the 1991 reorganization eliminated one management layer and customer satisfaction was made the responsibility of the lowest management level (field managers).

In 1989, in response to customer requests, IBM restructured its field service package. The result was ServicePlan, a streamlined service contract with all terms and conditions simply stated that can be easily tailored to each customer's unique business needs. A part of ServicePlan, Multi-Vendor Services, offers a one-stop, single-service manager program. As the primary contractor, IBM personnel perform contract administration; prepare

invoicing and billing notices; and manage maintenance, engineering changes, equipment changes, and installations. IBM customer engineers repair IBM products and third party service providers are utilized to repair other manufacturers' products. In addition to third party service providers, IBM service centers, independent product distributors and dealers, and mass merchandisers also provide service for IBM products. Certain IBM products are equipped with a remote diagnostics capability that allows remote analysis and correction of problems, often eliminating the need for an on-site visit.

IBM's maintenance strategy is remove and replace; a strategy based on field replacement units (FRUs)--modules that can be isolated, tested, and quickly replaced. To maintain a close relationship with the manufacturing and engineering functions, field service personnel (known as service delivery planning representatives or SDPRs) are located at each manufacturing plant and laboratory. SDPRs perform a variety of activities: performing as service advocates during product design and manufacturing, assisting in the development of maintenance analysis procedures, developing maintenance packages for new products, providing technical support, analyzing maintenance activity and parts usage to determine engineering change order requirements, and serving as a maintenance liaison between product/ manufacturing engineers and field service personnel. The current product life cycle is 5-7 years. During the product

life cycle, service activities and parts utilization for every machine type and model are tracked by the manufacturing plant of origin. Product engineers and SDPRs monitor these reports and initiate engineering change orders as required. End of support provisions vary by product and are based on factors such as product age, product population, failure rate analysis, and cost of repair. A three year notice of stop support is given to all customers.

Performance Measures

Customer engineers are evaluated by field managers, customer satisfaction surveys, and by reports generated by the National Service Support (NSS) system, a service activity tracking system. Field managers meet directly with customers to ascertain service quality. An annual customer satisfaction survey (mailed), telephone surveys, and product manager surveys (from the manufacturing plants) are also used to gauge customer satisfaction. NSS reports provide a measure of CE work performance such as parts usage, number of machines serviced, and response times to trouble calls.

In addition to individual CE performance, the Service Operations organization is evaluated on actual expenses/ revenue versus projected expenses/revenue. Maintenance cost estimates are developed for each product; actual costs are compared against the baseline estimates. Revenue targets are based on a percentage of product sales.

Customer complaints are handled at the lowest level possible. Customers are encouraged to work directly with

the first level of management, the field manager. If a complaint is elevated beyond the Service Operations Branch Manager, a formal complaint procedure is initiated requiring formulation of an action plan and a timetable for problem resolution.

Management Information Systems

The National Service Support (NSS) system consists of information systems, database management, and application programs designed to support the field service organization. Customer engineer service reports feed information into the NSS. This service information is available to Service Operations' managers, product and manufacturing engineers, and service delivery planning representatives through a variety of reports. NSS provides technical information required to track product performance and service quality as well as historical records of service calls and repair actions. This information allows the identification and analysis of out of tolerance variances, provides assistance in solving current maintenance problems, and identifies parts that may require engineering changes.

The Digital Communications System (DCS) links NSS with the CEs' portable terminals, area dispatch operations, branch locations, and various IBM support centers. The DCS is the nation's first private, totally digital, two-way radio communications system.

Service Processes

Customer service coordinators (CSCs), located at eight geographically dispersed Area Communications Centers, receive customer trouble calls via an 800 number. Utilizing the customer's phone number and machine type, the CSC accesses the customer profile and identifies the responsible CE or appropriate remote support group. Remote support groups may be either Customer Assistance Groups (CAGs) or a Remote Support Facility (RSF).

Customer Assistance Groups are utilized to support certain critical system units (determined by the service contract) and consist of highly skilled support personnel familiar with the specific products. CAGs can often solve the problems over the phone and if a solution is not possible, CAGs determine parts, tools, and a maintenance action plan concurrent with CE dispatch. Some IBM systems are equipped with remote equipment diagnostics that can be run by RSF personnel. A teleprocessing link between the RSF and the customer system allows problem analysis and sometimes correction. As with the CAGs, if a CE must be dispatched, a maintenance action plan, to include parts and tools, is developed.

If a CE must be dispatched, problem information is transmitted via the Digital Communications System to the CE's portable terminal (PT). The portable terminal is a two-way communication device that resembles a laptop computer; the PT links the CE to the NSS as well as to the

Parts Inventory Management System (PIMS). The portable terminal beeps to notify the CE of a call and as the CE completes the maintenance, activity information is entered into the PT and transmitted to the NSS for processing.

Three levels of technical support are available to assist customer engineers experiencing difficulty in resolving maintenance problems. Maintenance specialists with increasing levels of skill and experience are located in branch and area offices (Level 1), IBM support centers (Level 2), and manufacturing facilities (Level 3).

Service Parts Management

IBM's service parts logistics system is known as the Parts Inventory Management System (PIMS) and yearly handles 6 million parts transactions for over 26.3 million line items valued at $4 billion. PIMS tracks inventory by part number at all stocking locations and for 90-95% of customer requirements, parts are delivered within 4 hours. Customer engineers have direct access to PIMS through their portable terminals and may order parts directly from any stocking location (with the exception of manufacturing plants).

Parts are stocked at five levels: (a) 1500 outside locations (CE stock, branch offices, customer locations, parts vans), (b) 90 emergency parts stations, (c) 5 Field Distribution Centers, (d) the National Distribution Center (NDC), and (e) manufacturing plants. IBM also utilizes the Federal Express Business Logistics Warehouse in Memphis to supplement the service provided by the Field Distribution

Centers. Various modes of transportation, provided by private couriers and local IBM parts vans, are used to move parts to the point of need. Location of the part and the type of order--emergency or replenishment--determine the choice of transportation.

The NDC provides 24-hour emergency parts service for orders that cannot be satisfied locally and replenishment parts for all lower levels to include independent dealers, third party maintainers, and self servicers. Inventory planning personnel at the center are responsible for procurement, planning, and maintenance of the entire parts network. These inventory planners also determine the repair schedule for reworkable parts. NDC distribution operations personnel handle transportation, warehousing, and packaging of parts. The PIMS system is also located at the National Distribution Center.

OPTIMIZER is a multi-echelon inventory system developed and recently implemented by IBM to provide optimal control of service levels and spare parts inventory. OPTIMIZER forecasts parts stocking levels, establishes a reorder point, calculates an economic order quantity, and provides automatic ordering and shipping of replenishment parts for stocking levels 2, 3, and 4 when the reorder point is triggered. Level 1 stocking is controlled by customer engineers who are assisted by parts administrators located at the branches.

OPTIMIZER is integrated with PIMS. The two systems allow IBM to forecast demand, establish stocking objectives at all locations based on cost/service level, automatically replenish stocks based on calculated reorder points and economic order quantities, link each customer machine to a list of service parts numbers required for support, and track direct and backup parts support locations for each field installed machine by machine type, model, and serial number. The basic performance measure for PIMS is the Parts Availability Level (PAL). PAL is a measure of the fraction of parts' demand that is filled immediately from on-hand stock at a stocking location (Cohen, Kamesam, Kleindorfer, Lee, & Tekerian, 1990).

Ces drop off returnable parts at the branch parts center. The branch office ships these parts monthly to one of three used parts return centers. At the centers, parts are sorted and shipped to: manufacturing plants for failure analysis, rework vendors, the IBM repair center, precious metal recovery, or special environmental disposal.

Amdahl Corporation

Field Service Organization

Amdahl focuses on one segment of the data processing market--large system users utilizing the IBM System/370 software and extensions. Large general purpose mainframe computers comprise the bulk of the company's product line. Compared to its major competitors (NCR, IBM, Unisys), Amdahl

is a relatively small company in terms of personnel and installed products.

A corporate Vice President (VP), Customer Services, Worldwide heads Amdahl's customer service organization. Under the corporate VP, field service operations in the United States are managed by a Vice President, Customer Services, U.S. Operations. Completing the field service organization are regional directors, district managers, field managers, and finally, field engineers (FEs). U.S. Operations are supported by corporate (Customer Services, Worldwide) financial, personnel, training, and administrative services. Corporate also supplies centralized diagnostic assistance and trouble call receipt. To assist in parts support, a Manager of Logistics serves on the staff of the VP, U.S. Operations. Field service operations is a profit center.

Strategy

Amdahl stresses technological leadership in all areas--product manufacturing, product testing, product maintenance, and in the products themselves. Amdahl's customers demand high performance products as well as high levels of system availability. Customer service and after-sales support are critical to Amdahl's business.

To maintain high levels of availability, Amdahl pioneered remote diagnostics--a feature that often allows a problem to be detected and corrected remotely, utilizing teleprocessing links, before the system is impacted.

<u>Field Service Organization</u>
- -Reorganized in 1991
  - -Formerly National Service Division (NSD)
  - -One management layer eliminated
  - -Now part of U.S. Marketing and Services
    - -General Manager, Marketing Area; General Manager, Trading Area; Branch Manager, Service Operations; field managers; field engineers
- -Centralized field service support provided by U.S. Marketing and Services (national) and Area Managers Services
  - -Training
  - -Communications
  - -Parts support
  - -Information processing
  - -Technical support
- -Field service managers co-located with marketing and professional services (consulting) personnel
  - -Provides complete, packaged solution to customer needs
- -Profit center

<u>Strategy</u>
- -Maintenance support serves as part of team approach to customer needs
  - -Service partnership with customer stressed
- -Flexible, customer-tailored service contracts
  - -Single service contract manager
    - -Third party service providers for non-IBM products
  - -Service contracts supplemented by:
    - -Customer carry-in (IBM Service/Exchange Center)
    - -Independent retailers of IBM products
- -Remove and replace maintenance strategy
- -Field service closely tied to manufacturing
  - -Customer engineers (service delivery planning representatives or SDPRs) assigned to each manufacturing plant and lab
    - -Service advocates during product design and manufacturing
    - -Maintenance liaison between product/manufacturing engineers and field service
    - -Participate in a variety of maintenance and parts usage analysis and planning activities

<u>Figure V-2</u>. International Business Machines Within-Case Analysis Summary.

<u>Strategy (Continued)</u> -Product life cycle 5-7 years   -Three year notice of stop support provided -Remote diagnostics available on some products

<u>Performance Measures</u>
-Traditional accounting
    -Actual expense/revenue versus projected
        -Projected expenses based on service cost estimate developed for each product
        -Revenue targets based on percentage of product sales
-Customer satisfaction
    -Responsibility of lowest management level
    -Measured by:
        -Manager/customer meetings
        -Annual survey (mailed)
        -Product manager surveys (from manufacturing facility)
        -National Service Support system reports
-Formal customer complaint procedure
    -Initiated if complaint elevated above Service Operations Branch Manager

<u>Management Information Systems</u>
-National Service Support (NSS) system
    -Contains all field service activity information
    -Provides field service management reports
    -Provides maintenance analysis data for SDPRs and manufacturing plants/labs
-Digital Communications System (DCS)
    -Links NSS with all levels of field service support, including customer engineer
    -Digital, radio communications system

<u>Service Processes</u>
-Toll-free number for customer
-Calls received by one of eight Area Communications Centers (ACCs)
-ACC notifies:
    -Appropriate remote support group
    -Assigned CE
-Remote support groups (Customer Assistance Group, Remote Support Facility)
    -Attempt telephone solution
    -Provide maintenance plan and suggested parts if CE dispatch required

<u>Figure V-2</u>. <u>Continued</u>

<u>Service Processes (Continued)</u>

- -Customer engineer
  - -Receives call notification and information on portable terminal (PT) through DCS link
  - -Provides activity report to ACC and NSS through PT when maintenance complete
- -CE maintenance problem escalation
  - -3 levels available
    - -Branch and Area offices
    - -Support Centers
    - -Manufacturing facilities

<u>Service Parts Management</u>

- -Centralized parts management and distribution
  - -National Distribution Center (NDC),
- -Stocking echelons
  - -Manufacturing plants (Level 5)
  - -NDC (Level 4)
  - -Field Distribution Centers (Level 3)
    - -Supplemented by Federal Express Business Logistics Warehouse, Memphis
  - -Emergency parts stations (Level 2)
  - -Outside locations (CE stock, branch offices, customer locations, parts vans; Level 1)
- -Parts Inventory Management System (PIMS) tracks all inventory transactions and locations
  - -Directly accessible by Ces through portable terminal
- -OPTIMIZER system
  - -Forecasts parts stocking levels
  - -Establishes reorder point
  - -Calculates EOQ
  - -Provides automatic ordering and shipping of replenishment parts (levels 2,3,4)
    - -Level one stocking controlled by CE
  - -Integrated with PIMS
- -Transportation
  - -Multiple modes, selection based on location of part and urgency of need
- -Returnable parts
  - -Manufacturing plants (failure analysis)
  - -Rework
    - -Vendors
    - -IBM repair center
    - -Schedule controlled by NDC
  - -Precious metal recovery
  - -Environmental disposal

<u>Figure V-2</u>. <u>Continued</u>

Another technological innovation, patrol circuitry, scans computer storage areas and detects and corrects intermittent errors before they become severe. Amdahl also designs its processors to allow field engineers to conduct repairs during operation--customers lose access to only a small part of the processor's resources. Finally, to minimize system failures, Amdahl conducts extensive component and subassembly testing during development and production in order to provide product reliability that exceeds prevailing industry levels.

Teamwork pervades the entire Amdahl corporate organization. Multi-functional teams--drawing members from marketing, customer services, engineering, and manufacturing--work on product design; search for solutions to customer reliability, availability, and serviceability problems; work to develop and implement engineering changes; and, through system assurance reviews, insure new accounts are successfully initiated. This team approach extends to the field manager/customer working level. Field managers are expected to work closely with customers to understand business requirements and to develop service plans to meet customer needs.

Amdahl products are designed for expansion and upgrade, thus extending the product life cycle. However, technological upgrades cannot be incorporated indefinitely and when a product is discontinued and service support

ended, customers who elect to retain the discontinued system are provided a "last buy" of parts.

Amdahl has traditionally repaired only its own products. However, responding to market trends and customers' desires, Amdahl now will serve as a single maintenance manager. In the multi-vendor environment, Amdahl serves as a single maintenance point of contact. However, Amdahl contracts all service (as well as parts stocking and management) for other vendors' products to third party service providers.

Performance Measures

A monthly competitive activity report is prepared for each region to track field service performance. The report monitors parts activities (damaged parts, improper paperwork, failure to return parts for rework, failure to acknowledge parts receipt), maintenance delays, overdue field engineer appraisals, and status of system upgrade installations.

Managers are evaluated in three areas: customer satisfaction, expenses/revenues, and employee satisfaction. Customer Services is measured by an annual, corporate customer satisfaction survey which is hand-delivered to all customers. This survey measures field engineering performance (e.g. response time, parts deliveries, system availability) as well as customer perceptions of field engineers--courtesy, appearance, adequacy of training. Results of the corporate survey are compared with industry

surveys purchased from independent research sources. Since field service operates as a profit center, expense/revenue (E/R) measures are used to gauge performance. E/R measures are based on targets set by the VP, Customer Services, Worldwide. Employee satisfaction is gauged by annual surveys.

There is no formal procedure for placing complaints--complaints may be reported to field engineers, any level of management, or to problem call receipt personnel. If a complaint should occur, it is logged, worked, and monitored at the appropriate level until solved.

Management Information Systems

The Field Activities Support Tracking (FAST) system is used to track service performance and to manage parts; the system contains data on field service performance, parts usage and location, engineering change orders, and machine history records. FAST receives data from all field engineer service activity reports and is the source of the Competitive Activity Report used by Customer Services' managers. The system is also used by engineering to develop a solutions database and to perform product failure analysis. Other users of FAST data include reliability, availability, and serviceability teams and parts management personnel.

Service Processes

An 800 number allows customers to contact a central Customer Services Center (CSC). The CSC is manned by

engineers possessing both field service and software training/experience. CSC engineers attempt to work with customers and correct problems over the phone. Remote diagnostics can be run from the CSC and the solutions database can also be checked for solutions to similar problems. If the problem cannot be corrected, the customer's file is accessed and the appropriate field engineer notified by telephone pager. FEs are equipped with portable laptop computers (with modem links) with which they obtain trouble call information. CSC engineers will provide diagnostics results and will often suggest or order parts for the FE. After performing the repair, the FE provides a completion report via the laptop (and FAST system) to the CSC. Parts usage data is reported via telephone to the Central Parts Data Collection Department at corporate headquarters which initiates parts replenishment actions.

FEs are provided assistance in solving maintenance problems by a problem escalation staff composed of FEs with advanced training and experience. Each region has FEs, known as second level staff, who are available as on-site advisors. Further assistance is available at the corporate level from second and third level staff assigned to the Amdahl Diagnostic Assistance Center (AMDAC). AMDAC engineers can provide assistance by telephone and electronic computer links.

Service Parts Management

The Manager of Logistics is responsible for centralized inventory planning, management, and control. Inventory planning teams--composed of representatives from engineering, parts management, and customer service--determine level of repair and prepare initial and revised parts forecasts. Initial parts forecasts are based on reliability test results from production and manufacturing tests. Historical parts usage, collected from the FAST system, is used to revise initial forecasts. Reworkable parts are repaired as soon as received and returned to stock.

Dayton, Ohio serves as the national parts warehouse and distribution center. This national stocking location is managed by Emery Air Freight and provides replenishment stock for all lower echelons. Replenishment orders are based on one-for-one usage. Air Freight Depots, strategically located throughout the U.S., are managed by Associated Air Freight and provide support for emergency orders. The Manager of Logistics' staff monitors and controls inventory items, inventory levels, and orders (both emergency and replenishment) at the contract operations. Replenishment orders are initiated by the Central Parts Data Collection Department; the Emergency Parts Center coordinates emergency orders.

Parts are also stocked at the regional headquarters, in certain major metropolitan locations with high

concentrations of installed systems, and at customer sites. Regional Logistics Administrators perform parts management for these stocking locations. In general, high failure, high use, parts are stocked close to the customer. Low failure, high dollar parts are stocked in Dayton and at the Air Freight Depots and are moved by rapid air transport.

Hewlett-Packard

Field Service Organization

Hewlett-Packard (HP) utilizes a matrix organizational structure to provide customer support; two organizations are involved: Worldwide Customer Support and Marketing, International. Worldwide Customer Support provides both hardware and software support through a customer engineer (field service) work force. Additionally, Customer Support provides education and training for customer engineers (CEs) and operates two response centers that provide telephone assistance to both CEs and customers. A Vice President of U.S. Field Operations is responsible for the management of the U.S. field service force. Field Operations consists of the customer engineer work force and a managerial force headed by a U.S. Customer Engineer Operations Manager who is supported by region, area, field, and district customer engineer managers. In the early 1970s, Field Operations was changed from a cost center to a profit center.

The marketing organization (Marketing, International), provides centralized support functions for both sales and

<u>Field Service Organization</u>
- Part of Customer Services, Worldwide
  - Worldwide provides centralized support
    - Financial
    - Personnel
    - Training
    - Administrative
    - Diagnostic assistance
    - Trouble call receipt
  - Vice President, Customer Services, U.S. Operations manages U.S. field service
    - Supported by regional directors, district managers, field managers, and field engineers
    - Manager of Logistics provides parts support
- Profit center

<u>Strategy</u>
- Company stresses technological leadership to provide high performance and system availability to customers
  - Pioneered remote diagnostics
  - Developed patrol circuitry
  - Designs processors to allow maintenance during operation
  - Product reliability exceeds industry standards
  - Designs processors for expansion and upgrade
- Field managers expected to:
  - Understand customer's business requirements
  - Develop service plans to support customer needs
- Single maintenance manager
  - Third party service providers utilized for non-Amdahl products
- Multi-functional teams used throughout company
  - Product design
  - Engineering changes
  - Reliability, availability, serviceability
  - System assurance reviews (new accounts)
- Product life cycle variable
  - Last buy of parts for discontinued units offered to customers

<u>Figure V-3</u>. Amdahl Within-Case Analysis Summary

<u>Performance Measures</u>
- Corporate expense/revenue targets
- Monthly Competitive Analysis Report (CAR) from Field Activity Support Tracking (FAST) system
- Customer satisfaction
    - Annual survey, hand delivered to all customers
- Employee satisfaction
    - Annual survey
- Customer complaints
    - Complaints received at any level
    - Tracked until resolved
    - No specified customer complaint escalation procedure

<u>Management Information Systems</u>
- Field Activities Support Tracking (FAST) system
    - Tracks all field service activity and parts usage
    - Used by field service managers; engineering personnel; reliability, availability, and serviceability teams, parts management personnel

<u>Service Processes</u>
- Toll-free number for customer
- Calls received at central Customer Services Center (CSC)
    - CSC engineers attempt phone solution
        - Phone solution unsuccessful, dispatch FE
            - Provide diagnostic information and suggest parts
    - Field Engineer
        - Telephone page notification
        - Laptop/modem link
            - Trouble call information
            - File completion report with CSC (FAST)
        - Telephone report of parts usage (Central Parts Data Collection Department)
    - Maintenance problem escalation
        - Second level staff, on-site advisors
        - Amdahl Diagnostic Center (AMDAC)
            - Second and third level staff
            - Telephone and electronic computer links

<u>Figure V-3</u>. <u>Continued</u>

Service Parts Management

- -Centralized inventory planning, management and control
  - -Manager of Logistics
    - -Central staff
      - -Inventory planning teams
      - -Central Parts Data Collection Department
      - -Emergency Parts Center
    - -Regional Logistics Administrators
    - -FAST
      - -Inventory tracking
      - -Historical usage database
- -Stocking echelons
  - -National parts warehouse and distribution center
    - -Dayton, Ohio
    - -Managed by Emery Air Freight
    - -Replenishment orders
    - -Controlled by Central Parts Data Collection Department
  - -Air Freight Depots
    - -Located throughout U.S.
    - -Managed by Associated Air Freight
    - -Emergency orders
    - -Controlled by Emergency Parts Center
  - -Regional headquarters
  - -Major metropolitan areas
  - -Customer sites
- -Transportation
  - -Replenishment/low failure/high cost
    - -Air transportation
  - -Emergency
    - -Rapid (same day or overnight) air transportation
- -Parts rework
  - -Facilities in Sunnyvale and Santa Clara, CA
  - -Parts immediately repaired when received and returned to national parts warehouse

Figure V-3. Continued

field service: development of strategic marketing and sales plans (to include service offerings), market research and competitive analysis, administrative and personnel support, and logistical support for Field Operations--facility/fleet planning and parts support. Personnel from both Marketing and Field Operations work closely with one another and are often co-located. The dual organization approach was designed to allow field service personnel to focus solely on customer support with marketing providing the support. Field Operations' personnel are also considered vital members of the marketing/sales team.

Strategy

HP operates in three principal market areas: medical, analytical (chemical, petrochemical, pharmaceutical, and biotechnology applications), and computer/test and measurement. Of the three areas, computer/test and measurement has been targeted as the company's major market area of the 1990s. Within that area, computers and computer networks will be the primary focus; test and measurement will be increasingly downsized. Computer networks often involve products from a number of vendors and to position itself for the 90s, HP supplemented the repair of its own products (original equipment manufacturer or OEM service) with the repair of other vendors' products (third party repair by HP field service engineers).

HP is committed to provide the finest nationwide (and global) support organization in the industry. To meet

customer support demands, a wide variety of hardware maintenance options are offered which can be tailored to customer needs. Advanced technological tools and techniques are also used to support the field service force: remote diagnostics allow correction of problems often without an on-site visit; predictive software is designed to identify and prevent problems before they occur; and solution libraries, containing customer system history and past solutions to maintenance problems, are available to assist field engineers. Two Response Centers were recently created to receive customer trouble calls, perform remote diagnostics, dispatch customer engineers, and supplement the CE problem escalation assistance provided by Area Customer Escalation Centers. Additionally, a goal of HP is the development of long-term customer relationships. Ces are assigned to specific customer accounts to allow the CE to know the customer, the customer's schedule, and the customer's business.

To insure serviceability of its products, HP assigns field service personnel to product design teams. Design teams are composed of representatives from marketing/sales, research and development, manufacturing, and customer service. Field service representatives function as service advocates and assist in formulating a general maintenance concept and plan for each product that addresses areas such as recommended spares, CE training requirements, and level of repair. These representatives also assist in the

formulation of engineering changes. For customer engineers, HP utilizes a remove and replace maintenance strategy--defective parts are returned to a central rework facility for repair. CE maintenance is supplemented by customer mail-in and carry-in repair.

HP's product support program consists of two phases: "end of support" and "end of assured support." Customer product support will be provided for a minimum of five years after the last production run (end of support) and for most products, an additional five years of support is available (end of assured support).

Performance Measures

Field Operations is a profit center and receives corporate financial guidance--managers are assigned financial targets with profit and loss statement responsibility. Managers also develop their own set of performance measures designed to track assigned financial targets as well as non-financial goals. HP promotes, company-wide, "management by objective" versus "management by directive" and each manager develops, in concert with his/her supervisor, a set of business fundamentals. Business fundamentals are manager-specific goals and objectives used to monitor system activity.

Customer engineers also determine, with their managers, goals and objectives. These goals and objectives are developed from a tailored position description and include

both quantitative (e.g. response time to customer call) and qualitative metrics (e.g. physical appearance, courtesy).

Customer satisfaction is measured by an annual customer satisfaction survey (mailed), visits from district customer engineer managers, mini-surveys mailed from district offices, Response Center telephone surveys, and by a variety of marketing group survey instruments.

All HP employees are trained to handle customer complaints; if the employee who receives the complaint cannot solve the problem, it is escalated to someone who can. The customer calls only one person; the person who can act on the complaint returns the customer's call. A customer complaint tracking system is utilized to provide trend analysis.

Management Information Systems

The Central Call Management Service system contains customer information files--account number, installed equipment, and CE assignment. Another system The Field Resource Management (FIREMAN) system utilizes a telephone paging system to dispatch customer engineers. The customer engineer also accesses this system to obtain customer service order information and to enter repair data in the form of a maintenance completion report. The repair data contained in FIREMAN serves as an input into the Worldwide Service File database which is the source of activity reports utilized by a number of HP organizations. For example, marketing utilizes the information to perform

service agreement pricing reviews; parts management, engineering, and design team personnel review failure rates of products and components in order to adjust stocking levels and to develop engineering change orders.

Service Processes

To place a service call, customers contact HP's Central Call Management Service utilizing an 800 number. Call management personnel access the customer database and determine the CE assigned to the account. The appropriate CE is notified of the service call by a telephone pager. Upon notification, the CE accesses the FIREMAN system via a laptop computer with modem link. Customer service order information is downloaded and displayed on the laptop. As the CE progresses through the repair process, repair activity is entered into the laptop and forwarded to the FIREMAN system. If a CE experiences difficulty in performing a repair, assistance is available from an Area Customer Escalation Center or the Response Centers.

For Hewlett-Packard 3000 systems with remote support capability (diagnostics) or Predictive Support software, customers contact a Response Center for assistance. If the problem cannot be solved remotely, Response Center personnel notify Central Call Management and a CE is dispatched. The CE is provided diagnostic results and recommended parts by the Response Center.

Service Parts Management

Service parts for HP products are provided by HP manufacturing facilities. Parts for other manufacturers' products are obtained directly from the manufacturer or from fourth party parts providers.

Roseville, California serves as the primary stocking location for the United States and provides centralized parts management as well as replenishment orders to lower stocking levels. Ces carry high failure, high volume parts in parts kits tailored for the products they maintain. To back up CE kits, high-volume/high-failure parts are also stocked at local (district) offices. Area Logistics Centers, dispersed within each geographic area, serve as support pools for the offices stocking high-cost, low-failure, machine-critical parts and provide parts on demand. Emergency parts orders are placed by Area Logistics Managers or district parts specialists who can locate the part nationwide and arrange direct shipment to the CE. Federal Express is used for next day delivery; for more critical needs, Delta Dash is utilized with a 4 hour delivery goal. To minimize parts stocking costs, high cost and low failure components are stocked at area locations and rapid transportation utilized.

The FIREMAN system interfaces with the parts management system (the Service Asset Management System or SAMS); parts usage reported by Ces in the FIREMAN system triggers a replenishment order in SAMS. SAMS accumulates parts usage

data and generates a one-for-one parts order with Roseville. Parts are ordered nightly from Roseville and shipped via Federal Express, second day delivery. The delivery destination for the replenishment order is dependent on the parts source code reported by the CE. If the CE installs a part provided by a back up location (district office or an Area Logistics Center), the replenishment order is routed to the office or center. A replenishment order for a part removed from a kit is sent directly to the CE.

If a part is designated as reworkable, SAMS generates an "exchange-old" record in addition to the part order. The "exchange-old" record must be closed out by the return of the defective part to the centralized parts rework facility in Roseville. Parts are repaired as required (based on usage demand) and returned to inventory at Roseville.

Parts usage for new products is forecast based on a "best-guess" comparison of historical usage of a similar part. For existing parts, forecasts are based on accumulated usage (failure data) extracted from SAMS.

General Electric Computer Service

Field Service Organization

General Electric Computer Service (GECS) provides electronic equipment repair and calibration, electronic equipment rental, and computer maintenance. A section of GECS, Computer Maintenance Service, operates as a third party service provider. Computer Maintenance Service consists of the Field Operations Group (the field service

<u>Field Service Organization</u>
- -Matrix organizational structure
  - -Worldwide Customer Support
    - -Hardware and software support
    - -Field service education and training
    - -Response Center operations
    - -VP U.S Field Operations
      - -Field service managers
        - -U.S. Customer Engineer Operations Manager
      - -Region, area, field, and district customer engineer managers
      - -Customer engineer work force
  - -Marketing, International
    - -Centralized support for sales and field service
      - -Personnel
      - -Administrative
      - -Strategic Planning
      - -Market research
      - -Logistical support
- -Profit center since the 1970s

<u>Strategy</u>
- -Company focus on computers and computer networks market for the 1990s
  - -Recently implemented third party repair capability provided by HP customer engineers
- -Offers a wide variety of maintenance options that can be tailored to customer needs
  - -On-site (CE)
    - -Stress CE/customer long-term relationship
    - -Remove and replace maintenance strategy
  - -Repair center
    - -Mail-in
    - -Carry-in
- -Advanced technological tools and techniques to support field service
  - -Remote diagnostics
  - -Predictive software
  - -Solution libraries
  - -Response Centers
- -Product design teams
  - -Field service representatives assigned as service advocates
    - -Work with marketing/sales, research and development, and manufacturing
    - -Assist in developing product maintenance plans and engineering changes

<u>Figure V-4</u>. Hewlett-Packard Within-Case Analysis Summary.

<u>Strategy (Continued)</u>

- -Product support
  - -End of support
    - -Minimum of five years after last production run
  - -End of assured support
    - -Additional five years of support (for most products)

<u>Performance Measures</u>

- -Corporate financial targets
- -Business fundamentals
  - -Management by objectives goals
    - -Financial and non-financial
  - -Developed by each manager
- -Customer satisfaction
  - -Annual corporate survey, mailed
  - -District customer engineer manager visits
  - -Mini-surveys mailed from district offices
  - -Response Center telephone surveys
  - -Marketing survey instruments
- -Customer complaints
  - -All employees trained to handle customer complaints
    - -Customer makes only one call
    - -HP employee solves the problem or escalates
    - -Person who can act on the complaint contacts customer
  - -Customer complaint tracking system for trend analysis

<u>Management Information Systems</u>

- -Central Call Management Service system
  - -Customer information files
- -Field Resource Management (FIREMAN) system
  - -Provides CE dispatching via telephone
  - -Field service activity database
    - -Used by field service managers, engineering, design teams, and marketing

<u>Figure V-4</u>. <u>Continued</u>

<u>Service Processes</u>

- -Toll-free number
  - -Response Center (one of two)
    - -Equipment with remote diagnostics and Predicative Support software
    - -Phone or remote problem correction
    - -Central Call Management Service notified and CE dispatched if problem cannot be solved
    - -CE provided diagnostic results and parts recommendations
  - -Central Call Management Service
    - -Direct CE dispatch
- -Customer Engineer
  - -Notified by telephone page
  - -Laptop with modem used to access FIREMAN for service call information
  - -Laptop used to send maintenance completion report to FIREMAN
- -Maintenance problem escalation
  - -Area Customer Escalation Center
  - -Response Center

<u>Service Parts Management</u>

- -Centralized inventory planning, management, and control
  - -Roseville, CA
  - -Close coordination with Area Logistics Managers
- -Inventory tracked via Service Asset Management System (SAMS)
  - -Interfaces with FIREMAN
  - -Initiates replenishment orders (one-for-one) automatically when CE reports parts usage in FIREMAN
  - -Historical database of parts usage for forecast development

<u>Figure V-4</u>. <u>Continued</u>

Service Parts Management (Continued)

- -Stocking echelons
  - -Roseville, California
    - -Primary stocking location
    - -Replenishment orders
  - -Area Logistics Centers
    - -Dispersed within geographic areas
    - -High-cost, low-failure, machine-critical parts
  - -District offices
    - -High-volume, high-failure parts
    - -Back-up for CE kits
  - -CE parts kits
    - -High-volume, high-failure parts
    - -Tailored to CE products serviced
- -Centralized rework facility
  - -Parts repaired as required based on demand
- -Transportation
  - -Replenishment
    - -Federal Express, second-day delivery
  - -Emergency
    - -Federal Express (overnight)
    - -Delta Dash (same day)

Figure V-4. Continued

work force, known as field service representatives or FSRs, region managers, and district managers) and a variety of support functions: depot repair; training; call receipt and dispatching; information systems; contract support; engineering; and parts planning, repair, and distribution. A centralized GECS sales and marketing group conducts market research, develops service marketing strategy, and performs maintenance sales activities. Sales and marketing personnel are co-located and work closely with field service personnel at the headquarters and regional offices. Field Operations is a profit center.

Strategy

GECS focuses on Fortune 500 companies that operate in a multi-vendor, multiple location environment. Nationwide maintenance, single-source convenience (one maintenance provider for all brands of equipment), and independence (GE does not manufacturer or sell computer equipment) are strong maintenance selling points.

GECS is a total customer service company and attempts to build long-term, service partnerships with customers. When new accounts are started, an implementation team, consisting of representatives from service, material, training, engineering, and contract administration, is formed to insure quality, customized service is provided immediately. After the account is established, an account manager assumes responsibility for customer service, serving as a liaison between the customer and GECS.

Customers are offered a variety of service offerings which can be tailored to each customer's needs. Customers may choose all or a combination of: corrective repair, preventive maintenance, on-site installation, and equipment upgrades. On-call, corrective maintenance can be provided with a variety of response times and hours of coverage. Customers may also take or ship defective units to one of 21 maintenance depots for repair. Responding to market demand, GECS is currently expanding its service offerings to include software maintenance, system design, and warranty work.

GECS has determined that customers do not desire lengthy, on-site repair. To respond to this desire, FSRs perform remove and replace maintenance. Defective components (e.g. circuit boards, key boards, disc drives) are swapped with new components. No component level repair is done in the field; instead, repairable parts are returned to the National Repair Center (NRC) in Norcross (Atlanta), Georgia or original equipment manufacturers for test and repair.

GE does not manufacture computer equipment and therefore does not have a maintenance feedback loop to an internal product design and manufacturing operation. (The maintenance feedback loop is often a source of engineering change orders.) A part of GECS, the Technical Support Unit, does however, provide a link to product vendors and manufacturers. Technical support engineers monitor product

reliability and quality, providing information to product manufacturers.

Performance Measures

Prior to 1987, field service measures were "bottom line" or monetary. Currently, GECS managers are evaluated in the following areas: quality of service (customer satisfaction), employee management (morale/employee evaluation, appraisals), asset management (spare parts, diagnostics), and expenses/revenue.

Customer satisfaction is measured by monthly surveys. Every month, the district manager selects a random sample of 10% of the customers and conducts a telephone survey. Major account managers also are responsible for polling their customers at a minimum, once a month. Employee management is evaluated through manager/employee roundtables and by measures such as turnover rate and productivity. The Dispatching And Reporting Transactions (DART) system serves as the primary source of asset management information and provides reports in areas such as emergency parts orders, repairable parts returns, inventory turns, and inventory valuation. Since field service is a profit center, traditional expense/revenue measures are also tracked with emphasis on managing inventory expenses.

A formal customer complaint escalation system is utilized, starting with the account manager and flowing upward through the region manager, the field operations group manager, to the head of Computer Maintenance Service.

Management Information Systems

The Dispatching And Reporting Transactions (DART) system is designed to track computer service activities nationwide; system information includes: inventory usage, inventory levels, installed equipment base, customer service histories, customer contract specifications, FSR assignments. DART is composed of two major subsystems: National Dispatch and Inventory Control. National Dispatch notifies and dispatches FSRs when service calls are received. Inventory Control tracks parts and provides information on inventory levels and items in repair. The system is used by field service managers, Technical Support Unit personnel (failure analysis), and by the National Distribution Center (parts usage and forecasting).

Service Processes

Customers contact GECS using an 800 phone number. Personnel at the Customer Support Center (CSC) collect information on the call and utilizing DART (National Dispatch) dispatch the appropriate FSR. If applicable (based on equipment type or configuration), the CSC will refer the call to Remote Services. Remote Services personnel attempt to screen out software related problems and often can affect a "telephone fix" of hardware problems by providing maintenance directions to the customer. Diagnostics may also be run by the customer (utilizing diagnostic diskettes) and transmitted to Remote Services for evaluation. If an FSR must be dispatched, the CSC is

notified and provided failure information and suggested parts to pass to the dispatched FSR.

FSRs are notified of a trouble call by a telephone paging system; a call to the FSR's voice mail account provides service call information. When the maintenance is complete, the FSR telephones the CSC and, utilizing a script, provides a completion report. Future plans call for a laptop computer, with modem, to provide two-way communication between the CSC (DART) and field service personnel.

Should an FSR encounter difficulty in making a repair, hardware product specialists, assigned to the Technical Support Unit in Atlanta, are available for assistance. In addition to their extensive service experience, technical support engineers have access to a detailed technical library, GECS depot repair technicians, and product manufacturers.

Service Parts Management

Service parts are purchased and managed by the National Distribution Center (NDC) which is responsible for all inventory planning and for replenishment stocking of all lower echelons. The NDC is also the only location that holds safety stock inventory. Two parts depots, in California and New Jersey, provide specialized parts support for large accounts located within close geographic proximity. Region and district offices stock low-failure, high-cost items. The lowest stocking level, the FSR's van,

contains high-failure, high-use parts. FSRs are provided parts usage reports and general parts management assistance by a parts management staff located at each regional office.

Emergency parts are shipped directly to the customer site by the NDC utilizing airborne, overnight express delivery. Replenishment orders (use-one, get-one) are automatically generated by DART based on FSR usage reports and are shipped weekly via United Parcel Service.

Initial stock levels for parts are based on manufacturers' failure data as supplemented by GECS engineering and logistical staff recommendations. Stock levels for established products are determined by usage analysis from the DART system.

Failed, repairable parts are returned to the National Repair Center in Norcross. Parts are reworked at the National Repair Center or, in the case of proprietary or unique components, shipped to the original equipment manufacturers for repair. The National Distribution Center controls the repair schedule.

American Telephone and Telegraph Computer Systems Field Service Organization

Computer Systems is one of 19 AT&T business units. It is headed by a president who is supported by three vice presidents responsible for operations (manufacturing, logistics, training), product development, and sales/service. The business unit staff provides centralized personnel, financial, and administrative support. Field

<u>Field Service Organization</u>
- -Computer Maintenance Service
  - -One of three GECS primary service areas
  - -Field Operations (field service) Group Manager
    - -Region managers
    - -District managers
    - -Field service work force (field service representatives or FSRs)
    - -Profit center
  - -Support functions
    - -Call receipt and dispatching
    - -Depot repair
    - -Training
    - -Information systems
    - -Contract support
    - -Engineering
    - -Parts management
- -Centralized sales and marketing support from GECS
  - -Marketing research
  - -Service marketing strategy
  - -Maintenance sales
  - -Co-located with field service personnel

<u>Strategy</u>
- -GECS is a third party service provider
  - -GE does not manufacture computers
  - -Single source of service for all brands
- -Wide variety of service offerings
  - -On-site options
    - -Remove and replace maintenance strategy
    - -Remote diagnostics
  - -Customer carry-in or ship to maintenance depot
  - -Currently expanding to offer:
    - -Software maintenance
    - -System design
    - -Warranty work
- -Stresses long-term, service partnership with customer
  - -Implementation team for new account start-up
  - -Account manager serves as liaison between GECS and customer
- -Service information and product problems provided to product manufacturers

<u>Figure V-5</u>. General Electric Computer Service Within-Case Analysis Summary.

<u>Performance Measures</u>

- -Prior to 1987, all measures monetary
- -Currently:
  - -Service quality (customer satisfaction)
    - -Monthly telephone survey by district manager
    - -Monthly major account managers poll
  - -Employee management
  - -Asset management
  - -Expenses/revenues
    - -Emphasis on inventory cost control
- -Defined customer complaint escalation system
  - -Account manager, Region manager, Field Operations Group Manager, head of Computer Maintenance Service

<u>Management Information Systems</u>

- -Dispatching and Reporting Transactions (DART) system
  - -Tracks all field service activity nationwide
  - -Two major subsystems
    - -National Dispatch
    - -Inventory Control
  - -Used by field service managers, Technical Support Unit (failure analysis), and National Distribution Center (parts management and forecasting)

<u>Service Processes</u>

- -Toll-free number
- -Customer Support Center (CSC)
  - -Remote Services
    - -Remote diagnostics
    - -Telephone fix
    - -Provide failure information/suggested parts if FSR dispatch required
  - -Direct FSR dispatch
    - -Telephone communication link
      - -FSR notified by telephone page
      - -Voice mail provides service call information
      - -Completion report to CSC
    - -Laptop with two-way communication capabilities under development
  - -Inputs service activity into DART
- -FSR problem escalation support
  - -Technical Support Unit
    - -Hardware product specialists

<u>Figure V-5</u>. <u>Continued</u>

Service Parts Management

- -Stocking Echelons
    - -National Distribution Center (NDC)
        - -Centralized inventory management
        - -Emergency order management
        - -Replenishment stocking of lower echelons
    - -Parts depots
        - -Specialized support for large accounts
    - -Region and District offices
        - -Low-failure, high-cost parts
    - -FSR van
        - -High-failure, high-use parts
- -Emergency orders
    - -Parts shipped directly to customer site
    - -Airborne overnight express
- -Replenishment orders
    - -Automatically generated by DART
        - -FSR reported parts usage triggers order
        - -Use-one, get-one
    - -Shipped weekly by United Parcel Service
- -Forecasting
    - -New products
        - -Manufacturers' failure data
        - -Supplemented by GECS engineering and logistics staff analysis
    - -Established products
        - -Usage analysis from DART
- -Rework
    - -Repair schedule controlled by NDC
    - -National Repair Center (GECS)
    - -Original equipment manufacturers

Figure V-5. Continued

service is the responsibility of the National Vice President (VP), Service located within the sales/service organization. The staff of the National VP, Service conducts service product marketing research, develops service pricing strategy, defines technical training requirements, prepares support standards, and promotes product serviceability. The service force, consisting of over 1400 customer engineers (Ces), is managed by regional, district, area, and service center managers.

Strategy

AT&T operates under a corporate financial plan that heavily impacts each business unit's strategy. Computer Systems allocates financial goals to lower management levels--including field service which is viewed as a revenue/profit generator.

Computer Systems offers maintenance plans that can be tailored to customer desires--service offerings and contract terms are considered a starting point, open to modification. Customer partnerships to meet unique, customer-defined requirements are the goal of the service process. Customer account responsibility is shared by sales and service.

Products may be serviced at a repair depot or on-site. Depot level, or centralized repair is a customer carry-in option. On-site repair, performed by customer engineers, is remove and replace. Currently, Computer Systems does not consider itself a third party service provider; the capability exists but it is small. In a multi-vendor

environment, Computer Systems will provide interim support for non-AT&T products while a customer converts to all AT&T products. Interim support is provided by AT&T customer engineers; subcontractors are not used. The CE service force is supplemented by resellers who market the AT&T product line and elect to provide service.

Until 1989, little attention was given to product serviceability requirements. Prompted by increased customer interest in after-sales product support, Computer Systems created product teams. Service representatives, assigned to product teams with manufacturing, design, engineering, and marketing personnel, are now participants in product development. Product serviceability has also been enhanced by remote diagnostics.

Two areas negatively impact computer maintenance: no defined life cycle for products and the lack of a clear service market definition. By not specifying stop support provisions for products, Ces are placed in a position of trying to support products when part availability is limited or virtually nonexistent. Service capability varies with geographic location--Computer Systems must decide if it wants to target only large metropolitan area markets (with high product densities) or provide standardized, nationwide service to all locations.

<u>Performance Measures</u>

Customer satisfaction with service is measured by a telephone survey conducted by a non-AT&T research company.

The staff of the National VP, Service specifies the information desired and manages the survey contract. In addition to the National VP, Service, survey results are sent to the regional and district levels. (Area and service center managers do not directly receive survey results.)

Field service managers are evaluated both on financial and customer service measures. Financial goals are developed within each business unit to support the corporate financial plan; these goals are known as a margin commitment (gross margin) and are expressed in dollars of margin. Twice a year, Ces are evaluated based on technical performance and customer relations. All service managers are expected to make two customer visits a month to discuss service performance. Sales also conducts a comprehensive customer interview/assessment process that includes service measures. A questionnaire is hand delivered to a select number of large accounts by the sales account manager. When the questionnaire is completed, the account manager picks up the questionnaire and discusses the results with the customer.

Customer complaints are investigated, tracked, and resolved by the individual (or their staff) receiving the complaint.

Management Information Systems

Four computer systems are used to support field service operations. Three separate systems track machine installation/removal actions and provide billing

information; contain CE employee data (including hours worked per day); and serve as a customer information and maintenance activity database. A software system, Platform, provides an operator interface between the various systems allowing rapid movement from one system to another. Information fed into one system does not automatically update other systems. Ces do not input information directly into the systems; instead their activities are reported, by telephone, to material handlers at the service centers or to personnel at the regional Computer System Administrative Center.

Field service managers receive formatted reports from the various systems in order to track service performance. Product teams review information to track maintenance activity, analyze failures, and to develop engineering changes.

Service Processes

An 800 telephone number connects customers to a national Remote Diagnostics Center (RDC). Call receipt personnel record customer problem information and direct the call to the appropriate product engineering group--engineers familiar with the customer's product or system. About 40 percent of the customer-reported problems are solved over the phone--through customer-directed maintenance or remote (modem) maintenance commands. For the remaining 60 percent, a CE must be dispatched.

When an on-site maintenance visit is required, RDC personnel notify the appropriate regional Computer System Administrative Center (CSAC) for CE dispatch. Based on the problem analysis, RDC engineers also suggest parts. Communication between the CE and the CSAC is by telephone: CE notification (telephone page), call acknowledgement (CE to CSAC), and CE maintenance completion report. A laptop computer or portable terminal with a telephone modem link is currently under development for CE use. If a CE experiences repair difficulties, assistance is available from both product engineering groups and product teams.

Service Parts Management

Parts are stocked at three levels: national (a central warehouse, the *Memphis Distribution* Center or MDC), service centers, and CE vans/customer locations. A Memphis Customer Service Group manages computer parts at the MDC and ships replacement orders to the service centers. Two systems track parts, one at the national level (the Detailed Parts Inventory Control System or DPICS) and one at the service centers (the Stock Status System). The national tracking system is not accessible by service center personnel. Ces do not have direct access to either system to locate or to order parts. Stock levels at the MDC are based on recorded field usage plus safety stock. For new products, service parts levels are estimated based on demand patterns for similar, existing products.

Service center managers determine the types of service parts they wish to stock and set their own inventory stock levels (within the financial plan inventory target). Material handlers at the service centers place parts orders when stock levels drop below a locally determined point. Order lot sizes are determined by the service center manager and, like stock levels, are affected by financial plan inventory targets. The service center manager may order up to the stock level or place a smaller order. Replenishment shipments are transported via contract carrier (UPS). Replenishment orders for Ces are generally one-for-one from service center stock.

Emergency parts orders are also placed by material handlers. If a CE does not have a required part, material handlers access the Stock Status System and search their local stock as well as that of geographically adjacent service centers. If the part is not available locally, the material handler contacts the Memphis Customer Service Group who searches DPICS for national inventory assets: all service center inventories, Memphis stock, and unrepaired stock (reworkable parts) at the Memphis Repair Center. If necessary, the National Maintenance Staff at Memphis is contacted for authorization to source parts from the next higher assembly or from the manufacturing line. Emergency orders are shipped via Federal Express.

Ces return reworkable parts to the local service center; material handlers ship (by Consolidated Freight) the

parts to the Material Planning and Procurement Center in Memphis. Parts are reworked by the Memphis Repair Center or shipped to outside repair facilities. Parts are repaired when the Customer Service Group initiates a repair order.

Cross-Case Analysis

Within-case analysis provided a means to detect the unique patterns of each case. Patterns for each case, grouped by research question subject areas, have been presented in the case summary narratives. Each narrative was then further condensed and the patterns highlighted in an accompanying figure--a figure designed to facilitate the next step in the research process: cross-case analysis.

The following cross-case analysis utilizes a format similar to the with-in case analysis--data (patterns) are arranged by the major subject area of each research question: field service organization, strategy, performance measures, service processes, management information systems, and service parts management. A table, containing a comparison of each company's practices, is presented by subject area.

Field Service Organization

The placement of the field service organization within the company hierarchy varied across the companies. In three cases--National Cash Register (NCR), International Business Machines (IBM), and American Telephone and Telegraph (AT&T) Computer Systems--field service operations are a subfunction of the marketing group or a combined marketing (sales) and

Field Service Organization
- Computer Systems business unit
  - Business unit staff, centralized support
    - Personnel
    - Financial
    - Administrative
  - Operations
    - Parts management
    - Training
    - Manufacturing
  - Product Development
  - Sales/Service
    - National VP, Service (field service)
      - Staff support
        - Marketing research
        - Pricing strategy
        - Technical training requirements
      - Field service managers
        - Regional
        - District
        - Area
        - Service Center
      - Field service work force (customer engineers)
      - Field service personnel co-located with marketing
      - Profit Center

Strategy
- Business Unit strategy heavily guided by AT&T financial plan
- Tailored service offerings
  - On-site
  - Customer carry-in (depot repair)
- Remove and replace maintenance concept
- Customer partnerships
- Sales/service personnel share customer account management responsibility
- Serviceability
  - 1989 push
  - Remote diagnostics
  - Common components
  - Product teams
- Minor third party maintenance offerings
- Service market under review
- No defined product life cycle

Figure V-6. American Telephone and Telegraph Computer Systems Within-Case Analysis Summary.

<u>Performance Measures</u>

- -Monetary
  - -Margin commitment (gross margin)
- -Customer satisfaction
  - -Telephone survey
    - -Non-AT&T research company
    - -Annual
  - -Service manager customer visits
    - -Two per month
  - -Sales questionnaire
    - -Hand delivered
    - -Selected large accounts
- -Customer engineers
  - -Technical performance
  - -Customer relations
- -Customer complaints
  - -Complaints received at any level
  - -Tracked until resolved
  - -No defined customer complaint escalation procedure

<u>Management Information Systems</u>

- -Four separate systems
  - -CE employee data
  - -Equipment installation, removal, and billing
  - -Customer information/service activity database
  - -Software system to provide operator interface with other three systems
- -No automatic updates between systems
- -Ces do not have direct access to any system
- -Serve as information sources for field managers, product teams, and Memphis Customer Service Group (parts management)

<u>Service Processes</u>

- -Toll-free number
- -Remote Diagnostic Center (RDC)
  - -Product engineering group
    - -Telephone fix
    - -Provide failure information/suggested parts if CE dispatch required
- -Computer System Administrative Center
  - -Notified by RDC
  - -Dispatch CE

<u>Figure V-6</u>. <u>Continued</u>

<u>Service Processes (Continued)</u>

- -Telephone communication link
    - -Notified by telephone page
    - -CE calls CSAC for service call information
    - -Completion report to CSC
    - -Laptop or portable terminal with modem under development
- -Inputs service report into service activity database

-CE problem escalation support
- -Product engineer groups
- -Product teams

<u>Service Parts Management</u>

-Stocking Echelons
- -Memphis Distribution Center (MDC)
    - -Centralized inventory management (Memphis Customer Service Group)
    - -Replenishment stocking of lower echelons
- -Service Centers
    - -Stock levels determined by Service Center Manager
    - -Service Center material handlers manage parts
- -CE vans/customer locations
    - -High-failure, high-use parts

-Two inventory tracking systems
- -Stock Status System (Service Center inventories)
- -Detailed Parts Inventory Control System (national)

-Emergency orders
- -Placed by Service Center material handlers after a search of local stock
- -MDC contacted
- -Shipped via Federal Express

-Replenishment orders (Service Centers)
- -Controlled by Service Center manager
    - -Determines reorder point
    - -Specifies order lot size
    - -Driven by inventory cost targets/ customer service levels
- -Placed by material handlers
- -Shipped by United Parcel Service

<u>Figure V-6</u>. <u>Continued</u>

Service Parts Management (Continued)
- -Replenishment orders (customer engineers)
  - -One-for-one replacement from Service Center
- -Forecasting
  - -New products
    - -Estimate based on similar, existing product
  - -Established products
    - -Recorded field usage plus safety stock
- -Rework
  - -Material Planning and Procurement Center (Memphis)
    - -Memphis Repair Center (internal)
    - -Outside repair facilities (non-AT&T)
  - -Parts repaired when ordered by MDC

Figure V-6. Continued

services group. For Amdahl and Hewlett-Packard (HP), field service is a part of a separate customer support organization. General Electric Computer Services (GECS), through its Computer Maintenance Service organization, is a third party computer service provider. The entire organization is dedicated to field service.

In all instances, whether a part of marketing or not, the field service force maintains close ties with marketing and sales. NCR, IBM, AT&T, and GECS field service personnel are co-located with marketing and sales personnel at various management levels. Amdahl utilizes a team approach throughout its corporate structure; field service engineers often work directly with marketing (as well as many other company functions) on product design teams and during system assurance reviews for new accounts. Within Hewlett-Packard, a variety of centralized support functions for U.S. Field Operations (field service) is provided by HP's Marketing, International, necessitating close field service/marketing coordination.

General support (e.g. financial, personnel, logistical, training) of the field service work force is centralized. For NCR, a separate marketing organization, the Customer Service Division or CSD, provides support for the field service force. U.S. Marketing and Services provides national support to IBM's field engineers; the national business unit staff of Computer Systems performs a similar function for AT&T field operations. As mentioned,

Hewlett-Packard's U.S. Field Operations function is supported by Marketing, International. Computer Maintenance Service receives national sales and marketing support from GECS. All other support functions for field service are contained within Computer Maintenance Service and are primarily grouped in or near headquarters in Atlanta, Georgia. Amdahl's U.S. Operations are supported by Customer Services, Worldwide.

In four of the companies studied (NCR, AT&T, Amdahl, and HP), a vice president (VP) directly heads the field service organization. The recent IBM reorganization combined field service, marketing, and professional services under an IBM senior vice president and general manager. Nationally, eight marketing areas composed of 64 trading areas were created. At the trading area level, branch managers are responsible for marketing, professional services, and service operations (field service). Although the senior VP and general manager is responsible for field service, the service operations branch manager represents the actual head of field service. In the case of GECS Computer Maintenance Service, the entire business is field service driven; a field operations group manager heads the field service force and is co-equal with managers of various support functions such as engineering, depot operations, and contract support.

All companies have designated field service as a profit center. Organizational practices are summarized in Table V-1.

Strategy

With the exception of GECS, to supplement the repair of their own products (original equipment manufacturer or OEM repair) and to provide "one-stop" maintenance management, all companies provide some form of third party maintenance: NCR and HP field engineers perform third party maintenance; AT&T field service engineers provide limited third party maintenance to customers in transition from a multi-vendor environment to AT&T products; IBM and Amdahl contract with third party service providers to service other vendors' products. GECS is strictly an independent third party service provider; GE does not manufacturer computers.

All companies offer customer-tailored service contracts for on-site maintenance support. Five of the companies supplement on-site service offerings with depot repair (customer carry-in or mail-in) and four are supported by a network of product retailers who provide service. Product retailers are not utilized by GECS. The nature of Amdahl's products (primarily large, general purpose mainframe computers) precludes the offering of either of these options.

A remove and replace (R&R) maintenance policy is followed by all companies. Advanced technological tools and techniques--remote and built-in diagnostics, solutions

Table V-1

Cross-Case Analysis: Field Service Organization

	Placement w/in Company	Marketing	Central Support	Head	Profit Center
NCR	Marketing Group	Co-located	Yes	VP	Yes
IBM	Marketing & Services	Co-located	Yes	Brch Mgr	Yes
AMD*	Customer Services	Team Coordination	Yes	VP	Yes
HP	Customer Support	Provides Field Service Support	Yes	VP	Yes
GECS	(SEE NOTE)	Co-located	Yes	Grp Mgr	Yes
AT&T	Sales and Service	Co-located	Yes	VP	Yes

*Amdahl

GECS Computer Maintenance Service is an independent, third party field service provider.

libraries, electronic communications links--are also used to speed (and sometimes preclude the need for) the on-site repair process.

Field service personnel perform an important role as product serviceability advocates. NCR assigns field service engineers to each manufacturing facility. IBM service delivery planning representatives (drawn from the field service force) are assigned to each manufacturing plant and lab. Multi-functional teams (including field service representatives) are utilized by Amdahl to design new products; to plan and implement engineering changes; and to improve system reliability, availability, and serviceability. HP's product design teams and AT&T's product teams perform similar functions. GECS does not manufacture the products its field engineers repair; however, it does track and report product problems to the various OEMs.

Although the product life cycle varies, all companies, with the exception of AT&T, provide some form of "stop support" for their products. A summary of field service strategy is presented in Table V-2.

Performance Measures

Field service operations of all six companies are designated as profit centers. For NCR, service revenues are dependent on the number and type of service contracts sold by marketing/sales. Field managers concentrate on controlling expenses, primarily overtime and inventory

Table V-2

Cross-Case Analysis: Field Service Strategy

	Third Party Maintenance	Contract Tailoring	Supplement On-site Maintenance
NCR	Yes-1	Yes	Yes
IBM	Yes-2	Yes	Yes
Amdahl	Yes-2	Yes	No
HP	Yes-1	Yes	Yes
GECS	Yes-3	Yes	Yes
AT&T	Yes-4	Yes	Yes

1 = Performed by company field engineers (internal)
2 = Performed by 3rd party service providers (contract)
3 = 3rd party service only
4 = Limited 3rd party preformed by AT&T field engineers

Table V-2 Continued

	Remove and Replace Maintenance/ Advanced Technological Tools Used	Manufacturing & Design Inputs by Field Service	Stop Support
NCR	Yes	Yes	Yes
IBM	Yes	Yes	Yes
Amdahl	Yes	Yes	Yes
HP	Yes	Yes	Yes
GECS	Yes	Yes	Yes
AT&T	Yes	Yes	No

costs. For each IBM product, a maintenance service cost estimate is developed; actual costs are measured against projected costs. Actual revenue is measured against projected revenue--projected revenue targets are based on a percentage of product sales. AT&T, Amdahl, and HP field service managers are assigned financial targets derived from the corporate financial plan. GECS expense management focuses primarily on costs associated with inventory. Revenue generated is dependent on maintenance contracts sold by marketing/sales. However, for all companies, performance measures are not limited to standard accounting metrics such as expense/revenue or profit/loss. Customer satisfaction is also considered important and is measured in a variety of ways.

Amdahl field managers hand deliver an annual customer satisfaction survey to all customers. IBM also uses an annual survey to gauge customer satisfaction. The survey is mailed to customers and is supplemented by product manager surveys and field manager/customer meetings. NCR mails surveys quarterly to one fourth of its customers. Customers are also supplied a customer report card, prepared by NCR, that details the company's performance. GECS district managers and major account managers use the telephone to poll customers monthly. AT&T's annual customer satisfaction survey is performed by a non-AT&T research company. In addition to the survey, service managers are expected to visit each customer at least twice a month. Sales

questionnaires that measure customer satisfaction with both sales and service performance are also a source of information. HP provides the most intensive sampling of customer satisfaction: an annual corporate survey (mailed), district manager customer visits, mini-surveys mailed from district offices, Response Center telephone surveys, and marketing survey instruments.

Each company recognizes the importance of responding to customer complaints and encourages customers to work with the lowest management level to resolve them. Procedures to elevate a complaint to a higher management level vary somewhat among the companies. NCR customers receive a corporate phone number for complaint escalation if they are dissatisfied with the response of lower management levels. Members of the NCR president's staff receive, track, and resolve such complaints. IBM also has a formal procedure that is initiated when a customer complaint is elevated above the service operations branch manager: an action plan and timetable for complaint resolution must be formulated. GECS specifies an escalation flow: account manager, region manager, field operations group manager, and finally, the head of Computer Maintenance Service. AT&T and Amdahl have no defined complaint escalation procedure; people receiving the complaint track and resolve the issue. Hewlett-Packard has perhaps the best developed approach to complaints--all employees are trained to handle customer complaints. The customer makes one call; the person receiving the call

either solves the problem or determines who in the company can resolve the problem. When the proper HP contact is determined, that person returns the customer's call. HP also tracks customer complaints nationally in order to perform trend analysis. Table V-3 portrays field service performance measures.

Service Processes

Toll-free telephone numbers connect customers with a field operations center(s): IBM has eight; NCR, five; HP operates two remote centers and one central call management service; Amdahl, GECS, and AT&T each provide support with one national center. With the exception of NCR, a problem screening process occurs. Engineers at the operations centers attempt to screen out software related problems, run remote diagnostics (if the equipment is so configured), and effect a remote fix (by telephone or electronically). If a field service engineer must be dispatched to the customer's site, diagnostic results, a maintenance plan, and recommended parts are supplied.

Field engineers have contact with the operations centers via voice telephone (AT&T, GECS), laptop computer with modem link (Amdahl, HP), hand held terminal with modem link (NCR), or portable terminal with radio link (IBM). AT&T and GECS are both developing a laptop with modem link capability. Engineers utilize these communication links to receive service call information, to provide service completion reports, to receive problem assistance, and to

Table V-3

Cross-Case Analysis: Performance Measures

	Accounting	Customer Satisfaction	Customer Complaint Escalation Procedure
NCR	Revenue Costs: Overtime and parts focus	Survey (mailed) Customer Report Card	Phone number for corporate contact
IBM	Revenue: Target % of product sales Costs: Actual versus product cost estimate	Survey(mailed)	Formal procedure when elevated above branch
Amdahl	Expense/ revenue targets from corporate	Survey(hand delivered)	Not defined
HP	Assigned financial targets and quotas based on corporate financial plan	Surveys (mailed and telephone) Customer visits	All employees trained to handle complaints; national tracking system
GECS	Expense/ revenue (emphasis on inventory expenses)	Surveys (telephone)	Specified escalation flow
AT&T	Margin commitment based on corporate financial plan	Annual survey Customer visits Sales surveys	Not defined

order parts. With the exception of AT&T and GECS, field engineers can also directly access field service and parts management information systems.

All companies provide some form of problem assistance to field service engineers. Engineers with advanced training and experience are available to provide on-site, telephone, and in some instances, remote diagnostics assistance. Service processes are summarized in Table V-4.

Management Information Systems

IBM, Amdahl, and GECS operate one central information system to track all field service activity. NCR has separate systems that maintain customer accounts, dispatch field engineers, and track field service activity. Hewlett-Packard maintains customer files in one system and provides dispatching and service activity tracking with another. AT&T has three systems that contain information--employee data, product installation/billing codes, customer accounts/ dispatching information/service activity--and one that serves as an operator interface allowing rapid movement from one system to another.

Maintenance activity reports from field engineers feed information to the service activity tracking systems. Service activity information is utilized by field service managers to monitor service performance and is provided to a variety of other company functions: marketing, manufacturing, design engineering, research and development labs, and to the various multi-functional product teams.

Table V-4

Cross-Case Analysis: Service Processes

	Customer Problem Reporting	Number of Ops Centers	Problem Screening	Field Comm. Link	Problem Escalation
NCR	Toll-free Telephone	5	No	HHT	Yes
IBM	Toll-free Telephone	8	Yes	PT	Yes
AMD*	Toll-free Telephone	1	Yes	LT	Yes
HP	Toll-free Telephone	3	Yes	LT	Yes
GECS	Toll-free Telephone	1	Yes	T	Yes
AT&T	Toll-free Telephone	1	Yes	T	Yes

* Amdahl

HHT = Hand-Held Terminal
LT = Laptop Computer
PT = Portable Terminal
T = Telephone (Voice)

Service activity reports provide source data for engineering change orders, design changes, parts failure analysis, and pricing of service offerings. Management information systems are described in Table V-5.

Service Parts Management

All six of the companies employ centralized service parts management and computerized inventory tracking/usage reporting. GECS and Amdahl track both service activity and parts' transactions in their DART and FAST systems respectively. Separate parts tracking systems are maintained by NCR (Field Engineering Inventory Management System), HP (Service Asset Management System or SAMS), IBM (Parts Inventory Management System or PIMS), and AT&T (two systems: Detailed Parts Inventory Management System or DPICS for national tracking and Stock Status System for service center inventories). All of these systems, in conjunction with the field service activity reporting system (or subsystem in the case of GECS and Amdahl), serve to provide a detailed, historical parts usage (failure) database that is central to the forecasting of service parts requirements--parts for both existing and new products.

Replenishment orders are automatically generated by IBM's OPTIMIZER (levels 2, 3, and 4), GECS' DART, and Hewlett-Packard's SAMS system. Amdahl also utilizes an automatic replenishment process initiated when field service engineers report parts usage (via telephone) to the Central Parts Data Collection Department. AT&T and NCR

Table V-5

Cross-Case Analysis: Management Information Systems

	Number of MIS	Major Functions	Interface with Other Company Functions	Direct Field Access
NCR	3	(CF,BL,ED)/(D)/(SA)	Yes	Yes
IBM	1	C	Yes	Yes
Amdahl	1	C	Yes	Yes
HP	2	(CF,BL,ED)/(D,SA)	Yes	Yes
GECS	1	C	Yes	No
AT&T	4	(CF,D,SA,ED)/(CF,BL)/(ED,SA)/(IS)	Yes	No

BL = Billing
CF = Customer Files
C = Consolidated (BL,CF,D,ED,SA)
D = Dispatch
ED = Employee Data (Field Engineers)
IS = Computer Interface System (Stand-alone System, AT&T only)
SA = Service Activity
( )= System Function(s)

replenishment orders (below the centralized stocking location) are managed jointly by field service managers and parts management personnel. The NCR field service district manager is responsible for inventory cost and determines timing and quantity of replenishments. AT&T follows a similar practice--parts personnel place the order when stock levels drop below a locally determined minimum. To maintain costs within assigned inventory value targets, the field service center manager determines the minimum stock levels and order quantities.

The transportation mode selected for repair parts is based on urgency (replenishment or emergency) of need. AT&T and GECS ship replenishment parts via United Parcel Service; NCR ships by truck (commercial carrier). Emergency orders (parts not available locally and required by the field engineer for immediate, on-site repair) for these companies are shipped by overnight or four-hour air service. Both Amdahl and HP rely solely on air. IBM utilizes various commercial carriers (both air and truck) based on the location of the part and the urgency of need.

With the exception of Amdahl, parts rework is controlled by the centralized parts management organization and repair is scheduled upon demand. For Amdahl, parts are repaired as soon as they are received from the field and upon repair, are immediately returned to inventory. Service parts management practices are outlined in Table V-6.

Table V-6

Cross-Case Analysis: Service Parts Management

	Central Mgmt	Parts Usage Database	Automatic Replenish	Trans. Modes	Parts Rework
NCR	Yes	Yes	No	EA/RT	C/OD
IBM	Yes	Yes	Yes (Levels 2,3,4)	V	C/OD
Amdahl	Yes	Yes	Yes	EA/RA	C/WR
HP	Yes	Yes	Yes	EA/RA	C/OD
GECS	Yes	Yes	Yes	EA/RA	C/OD
AT&T	Yes	Yes	No	EA/RA	C/OD

EA = Emergency Orders, Air
RT = Replenishment Orders, Truck
RA = Replenishment Orders Air
V = Variable, mode selected depends on type of part and urgency of need. However, in general, EA and RT apply.
C = Centralized rework schedule management
OD = On Demand, parts are reworked when needed.
WR = When Received, parts are reworked immediately upon receipt.

Stocking echelons vary: NCR utilizes 4; IBM, 5 (one of which is manufacturing plant); Amdahl, 5; HP, 4; GECS, 4; and AT&T, 3. In general, parts support is provided by stocking high failure parts close to the point of use (customer) and high cost, low failure, emergency parts at centralized (national or regional) stocking locations (see Table V-7).

Field Service Management Propositions

Within-case analysis focused on practices of the individual companies. Cross-case analysis allowed the detection and generalization of patterns across the case studies. Based on patterns identified by the cross-case analysis, a series of field service management propositions was developed. Table V-8 provides a summary of the management propositions. Following the table is a discussion of each proposition.

Organization

1. Close coordination between marketing/sales and field service is required to provide a "common face" to customers.

Bertrand (1988) notes that "teamwork between the sales and service units can mean the difference between a satisfied or disappointed customer" (p. 36). Four companies (NCR, IBM, AT&T, GECS) co-locate marketing/sales and field service personnel; in three of these companies (NCR, IBM, AT&T) the field service organization is a subfunction of the marketing or marketing/sales group. (GECS is a field service company providing third party maintenance service;

Table V-7

Cross-Case Analysis: Service Parts Stocking Echelons

Stocking Echelons	NCR	IBM	Amdahl
1	Field Engineers	Outside Locations	Customer On-Site
	HF/LV,OFO	HF/LV,OFO	HF/LV,OFO
2	Zone Offices	Emergency Parts Stations	Major Metro. Stocking Locations
	HF/LV,EM,RP, ROP/LDL	HF/HV,LF/HV, EM,ROP/EOQ	HF/HV,LF/HV, EM,OFO
3	District Offices	Field Distribution Centers	Regional Stocking Locations
	HF/HV,LF/HV, EM,RP,ROP,LDL	ALL,EM/RP,ROP/ EOQ,	HF/HV,LF/HV, EM,OFO
4	Worldwide Service Parts Center	National Distribution Center	Air Freight Depots
	ALL,EM/RP, TPOP/EOQ	ALL,EM/RP,ROP/ EOQ	ALL,EM,OFO
5	NOT USED	Manufacturing Plant	Dayton Warehouse/ Distribution Center
		EM	ALL,RP,ROP/ EOQ

Primary Parts Stocked:
LF = Low Failure
HF = High Failure
LV = Low Value
HV = High Value
ALL = LF/LV, LF/HV HF/LV, HF/HV

Primary Order Discipline:
EOQ = Economic Order Quantity
LDL = Locally Determined Lotsize
OFO = One-For-One
ROP = Reorder Point
TPOP= Time Phased Order Point

Principal Function:
EM = Emergency Orders (Parts not available for on-site repair.)
RP = Replenishment Orders

Table V-7 Continued

Stocking Echelons	HP	GECS	AT&T
1	Customer Engineers	Field Service Representatives	Customer Engineer/On-Site
	HF/LV,OFO	HF/LV,OFO	HF/LV,OFO
2	Local Offices	Region Offices	Service Centers
	HF/LV,EM, OFO	LF/HV,EM,OFO	ALL,EM,ROP/ LDL
3	Area Logistics Centers	District Offices	Memphis Distribution Center
	LF/HV,EM, OFO	LF/HV,EM,OFO	ALL,RP,ROP/ EOQ
4	Roseville, California (National)	National Distribution Center	NOT USED
	ALL,RP,ROP/ EOQ	ALL,RP,ROP/EOQ	
5	NOT USED	NOT USED	NOT USED

Primary Parts Stocked:

LF = Low Failure
HF = High Failure
LV = Low Value
HV = High Value
ALL = LF/LV, LF/HV
HF/LV, HF/HV

Primary Order Discipline (Replenishment):

EOQ = Economic Order Quantity
LDL = Locally Determined Lotsize
OFO = One-For-One
ROP = Reorder Point

Principal Function:

EM = Emergency Orders (Parts not available for on-site repair.)
RP = Replenishment Orders

Table V-8

Summary of Field Service Management Propositions

Organization
1. Close coordination between marketing/sales and field service is required to provide a "common face" to customers.
2. The field organization is supported by centralized, functional support units.
3. Field service is a major source of revenue and is managed as a profit center.
Strategy
4. Field service is a strategic imperative for achieving competitiveness.
5. One-stop maintenance management is a competitive necessity.
6. Market segmentation is achieved through on-site service contract tailoring and alternatives to on-site service.
7. Field service representatives must participate in product design, development, support, and modification.
8. Stop support provisions must be specified to insure realistic product support.
Performance Measures
9. A balance of financial, hard, and soft field service performance measurements is required.
10. Customer complaint procedures must be specified and complaints monitored, resolved, and analyzed.
Service Processes
11. Decentralized field engineer operations (maintenance activities) are centrally supported.
12. The key to effective field service in the computer industry is rapid response to and resolution of customer problems.
13. Customer problem screening must be utilized to improve field engineer productivity.

Table V-8 Continued

Service Processes (Continued)
14. Response and maintenance activity times are minimized through the use of advanced technological tools and techniques.
15. On-site maintenance is expedited by a remove and replace strategy.
16. Technical problem assistance must be readily available to field personnel.
Management Information System
17. Field service activity information must be shared with other company functions.
18. A field service activity database serves as a solutions library for maintenance problems and reduces maintenance time.
19. A computerized field service MIS facilitates the tracking and analysis of field engineer activities.
20. Field service maintenance activity information provides an indicator of customer satisfaction.
Service Parts
21. The management of electronic service parts should be centralized.
22. High use parts should be stocked as close to the customer as possible to provide minimum customer downtime.
23. Low use, high dollar value parts should be stocked in strategic locations and rapid transportation utilized to respond to customer needs.
24. Accurate forecasting, high visibility, and automatic replenishment (pull) of parts requires extensive computer power.
25. A pull system should be utilized throughout the logistics pipeline.

field operations is a separate group within the company.) Although field service operations are a part of a separate customer support organization in Amdahl and Hewlett-Packard; marketing and sales still maintain close ties. A team approach to satisfying customer needs characterizes Amdahl's operations; multi-functional teams respond to customer problems and coordinate the installation of new products at customer sites. Hewlett-Packard's field service force receives a variety of centralized support functions from the marketing organization.

2. The field organization is supported by centralized, functional support units.

For all six companies, general support (financial, personnel, sales/marketing, training) and operational support (logistics, call receipt, call screening, dispatching, and technical assistance) are centralized. The Association For Service Management International (AFSMI) and Arthur Andersen & Company (1988) conduct an on-going study of 40 companies that "represent a non-scientific, but reasonably representative cross section of the service industry" (p. 34). "Service industry" refers to "organizations that provide after-sales service for complex, high-technology products and software" (p. 2). Their study noted that most support functions for these companies are centralized; an observation supported by the six case studies in this research. Centralized support avoids staff

duplication at the decentralized field service operating units (see related proposition 11).

3. Field service is a major source of revenue and is managed as a profit center.

Field service no longer functions as an internal company department to provide adequate service at minimum cost. Each of the companies studied has recognized the field service organization as a major source of revenue; in each instance, field service is managed as a profit center--emphasis is on organizing and operating to make money.

In four of the companies studied field service is headed by a vice president. IBM field service managers receive equal status with marketing and professional services branch managers. *GECS, a special case,* is strictly a third party maintenance provider--the entire company is a field service organization.

<u>Strategy</u>

4. Field service is a strategic imperative for achieving competitiveness.

Increasingly, customers are placing a high emphasis on after-sales service support for the products they purchase (Bleuel & Bender, 1980; Blumberg, 1989a; McCafferty, 1980; Voss, Johnston, & Morris, 1985; Zemke, 1989). All six companies recognize the importance of field service to market competitiveness. For example, the 1991 IBM reorganization was designed to provide a service package to meet customers' needs--product sales, field service, and

consulting services were consolidated at the branch level. Amdahl is recognized as using technical (maintenance) service and responsiveness to customer concerns as an effective competitive strategy (Zemke, 1989, p. 399). Field service is not treated as secondary in importance or viewed as an "after thought;" instead it serves as a competitive edge. Marketing and sales personnel stress service in advertising and when soliciting product sales.

5. One-stop maintenance management is a competitive necessity.

Today, many organizations' information systems consist of products from various manufacturers. To simplify maintenance support, these organizations are demanding a single source supplier of maintenance service. Blumberg (1989b) identified the trend towards data networking (often involving the inter-linking of a variety of machine types from various manufacturers) as one of five key factors that will impact the electronics field service environment in the 1990s. He points out that electronics vendors must be able to service not only their products but also those of other manufacturers (p. 22). Third party maintenance (the ability to repair other manufacturers' products) is a competitive necessity; whether it is performed internally or by an independent maintenance contractor.

As an example, NCR's long-term product strategy, Open, Cooperative Computing (OCC), recognizes the trend towards increased networking and provides the capability for

different computers, subsystems, and software to operate together in a network configuration. This product strategy requires third party maintenance capability due to the possibility of a variety of other vendors' products linked with NCR products. NCR's challenge is to be selected as the third party, single maintenance manager. All of the six companies in this study provide some form of third party maintenance service.

6. Market segmentation is achieved through on-site service contract tailoring and alternatives to on-site service.

Heskett (1986) and Davidow and Uttal (1989) point out that market segmentation, based on a knowledge of customer demands, is critical for service organizations--Heskett believes that market segmentation is even more important to service organizations than to product manufacturers (p. 7). Service contract tailoring provides a means to segment customers based on contract specifications. For example, customers who depend heavily on computers may elect to pay a premium rate for a four-hour response time or a 95% guaranteed system uptime. Another customer, less dependent on computer availability, may be content to accept next-day service. For customers not desiring on-site service, carry-in and mail-in options are available at various repair centers--some company operated, some operated by product vendors.

All six companies emphasize the need for a partnership between the service organization and the customer. Contract

terms are a baseline; all terms are subject to customer modification. Field service personnel and account representatives are expected to have an understanding of the customers' business needs and to develop service plans based on those needs.

7. Field service representatives must participate in product design, development, support, and modification.

McCafferty (1980) and Patton (1986) note that field service feedback is an important source of product design improvements. Additionally, how a product is designed and manufactured can impact the ability of a field engineer to service that product. To insure product serviceability, field service representatives of the six companies studied participate in virtually all areas of product design, development, manufacturing, and support. Representatives from field service are assigned to research and development labs, to manufacturing plants, serve on multi-functional teams to address product reliability and serviceability, and participate in failure analysis to revise parts stocking lists and to recommend engineering change orders.

8. Stop support provisions must be specified to insure realistic product support.

With one exception, all companies recognized a product life cycle and the need to specify provisions for stop support. AT&T failed to do so and acknowledged this as a major support problem--at times, customer engineers had to be very creative.

Lee and Steinberg (1984) noted that last buy (end of support or stop support) life cycle procedures for service parts generally did not exist; their study identified this as a serious problem affecting the management of service parts and ultimately affecting the manufacturer's reputation for quality and service.

Performance Measures

9. A balance of financial, hard, and soft field service performance measurements is required.

Fitzgerald (1988) and Lash (1989) both call for a departure from the "single dimensional profit measures" (Fitzgerald, p. 347) for the service sector. A wider range of performance measures is advocated to include measures of service delivery. For field service specifically, Voss et al. (1985) proposes three sets of measures: hard performance, soft performance, and cost. Hard measures are easily quantified and measured; soft measures influence the customer's perception of service.

All of the companies studied operate field service as a profit center; financial measures are utilized to evaluate profit/loss performance. Additionally, all companies track the activity of field service engineers and the performance of products in one or more management information systems. Field engineers provide service activity reports that include elements designed to measure the maintenance performed--e.g. time of arrival, total time on customer site, duration of maintenance activities, type of failure,

part(s) used. Some of these "hard" elements also serve as indicators of customer satisfaction. For example, the comparison of equipment downtime or field engineer response time to a specific customer's contract specifications provides an indication not only of a field engineer's performance but also of customer satisfaction.

Soft measures (e.g. attitude, courtesy, and appearance of the field service representative; perceived efficiency of the company) of field service performance are collected through customer surveys (mail and/or phone) and through on-site interviews conducted by field service (and in some instances, marketing) managers.

10. Customer complaint procedures must be specified and complaints monitored, resolved, and analyzed.

Clark (1988) performed a study of after-sales service and reported that of the 170 companies he surveyed, relatively few had clear customer complaint procedures and the resolution of complaints was not monitored or controlled. All of the six companies in this study recognize the need to respond to and monitor customer complaints until they are resolved. When lower management levels are unable to resolve the complaint to the customer's satisfaction, four companies provide a defined customer escalation response.

As noted earlier, Hewlett-Packard not only monitors complaints but also tracks complaints utilizing the Customer Feedback System. This system captures all complaints (as

well as customer comments, suggestions, and compliments) in a historical database, allowing extensive analysis.

Service Processes

11. Decentralized field engineer operations (maintenance activities) are centrally supported.

Blumberg (1989b) notes that new technologies will increase the move toward centralization, particularly in the areas of dispatch, technical assistance, and logistics control. The operational support functions of call receipt, call screening (service call avoidance), dispatching, and technical assistance are complementary activities and are generally co-located in a central (national or regional) location. (For the companies studied, the number of locations ranged from one national service center to 8 regional centers.) Centralized logistics control will be discussed in the section on service parts.

Customer service centers are accessed around the clock via a toll-free telephone number. Call receipt personnel receive and document customer trouble calls. Service engineers discuss the problem with the customer and, where applicable, perform remote diagnostics. Call screening permits engineers to distinguish between software and hardware malfunctions. If necessary, field engineers are dispatched to the customer site (see related proposition 13).

For field engineers experiencing maintenance problems, centralized technical assistance is also available from a

staff of highly experienced engineers. Often these are the same engineers who perform the call screening process (see related proposition 16).

12. The key to effective field service in the computer industry is rapid response to and resolution of customer problems.

13. Customer problem screening must be utilized to improve field engineer productivity.

Voss et al. (1985) notes that substantial cost savings can be recognized if problem screening can eliminate the need for the dispatch of a service representative. Blumberg (1989a) offers call screening and call avoidance as major mechanisms for improving the productivity of the field service force. He states that the number of on-site calls can be reduced from 20% to 45% by utilizing these techniques (p. 20).

With the exception of NCR, the companies studied perform problem screening to detect software problems and to effect remote fixes either by customer performed maintenance or by electronic signals to the effected equipment. If the remote correction is unsuccessful, dispatched engineers arrive at the customer's site with full knowledge of diagnostic results and maintenance activities that have been attempted. Field engineers may also be provided a maintenance plan to include recommended parts. In some instances, the parts are ordered and shipped concurrent with the dispatch activities.

14. Response and maintenance activity times are minimized through the use of advanced technological tools and techniques.

Centralized call receipt, call screening, and remote diagnostics provide an around-the-clock, rapid response to customer problems. As previously mentioned, on-site maintenance can sometimes be avoided--repairs can be accomplished by the customer or electronically.

Field engineers also have access to a variety of advanced technological tools and techniques designed to minimize customer down time: hand-held terminals with modem or radio frequency communication links that allow direct access to field service management information systems; comprehensive maintenance activity databases, accessed by fast-search software to identify possible maintenance solutions; and predictive support software that monitors system performance and informs field engineers of maintenance needs before problems occur. All of the six companies studied use one or more of these advanced technological tools and techniques.

15. On-site maintenance is expedited by a remove and replace strategy.

Computers play a crucial role in today's competitive business environment--information processing systems are fundamental to an organization's performance and growth. Because of this crucial role, users of computers demand high levels of system availability, requiring rapid response to

and correction of customer problems. Field service organizations have responded to these needs by initiating a remove and replace maintenance strategy. All six companies recognize that field engineers can perform more repairs per day and perform each repair more rapidly by removing the defective part, inserting a new part, and returning the defective part to a central repair facility.

Blumberg (1989b) notes that remove and replace service is facilitated through technological advances in high density integrated microprocessor circuitry; this circuitry allows increased modularization of components. Modularization has allowed IBM to incorporate the remove and replace strategy into product design through the development of components (field replacement units) that can be isolated, tested, and quickly replaced.

16. Technical problem assistance must be readily available to field personnel.

Thomas (1987) identifies technical support as one of four major field service functions. Technical support is provided by experienced technicians (usually from a centralized location) who run remote diagnostics, assist field engineers in resolving difficult maintenance problems, and sometimes directly assist customers. Higgins (1989) states that technical support centers can provide improved service response and increase customer satisfaction.

To avoid maintenance delay and excessive equipment down time, a field engineer experiencing maintenance problems

must have immediate access to higher technical assistance. Centralized technical assistance centers, staffed by highly trained and experienced engineers are provided by all six companies to expedite the repair process. These higher level engineers have access to a variety of technological tools to assist in problem resolution.

Management Information System)

17. Field service activity information must be shared with other company functions.

Field engineers input activity reports directly (modem/radio link) into the MIS or contact (by telephone) service center representatives who enter the maintenance information. Maintenance activity is tracked and analyzed to determine both field engineer and product performance. In addition to field service, other company functions that typically have access to field service management information systems include: manufacturing, engineering (including research and development), marketing and sales, finance, and parts management personnel.

The field service management information system is an integral part of a product quality effort. Field service product performance information is used by interfunctional teams (engineering, manufacturing, marketing, field service) to create and modify design specifications. For example, maintenance activity, tracked by machine type, can serve as an indicator of poor product design or reliability. An

engineering change order or product redesign may result from maintenance activity analysis.

Maintenance activity analysis, coupled with a quality function deployment (QFD) process, places the quality emphasis on the product design process. The end result is improved product quality based on customer inputs of needs and preferences (QFD) as well as actual product performance feedback (field service maintenance activity reporting). The application of Taguchi experimental methods also offers great potential for linking field service activities to engineering design.

Marketing and sales personnel use service cost estimates--based on travel time, repair time, mean time between failures, and parts expense--to determine service product pricing and profitability. The comparison of actual service performance parameters with estimated is required to evaluate service product pricing. Additionally, parts management personnel are able to track parts usage, initiate replenishment orders, and determine optimal parts levels and stocking locations.

Field service management information systems and information flow were previously noted in Chapter II as being critical to not only the field service organization but also to the business as a whole. In addition to management information systems, the physical co-location of field service and marketing/sales personnel facilitates the cross-flow of information necessary to provide total

customer account support. The close ties, through field service representatives, with research and development, design engineering, manufacturing, and logistics support also insure field service information is passed to the required functions for product modifications, parts lists updates, serviceability enhancements, and other necessary actions.

18. A field service activity database serves as a solutions library for maintenance problems and reduces maintenance time.

Maintenance activity is tracked by part number, machine type, and in some instances, by customer and machine serial number. A maintenance activity database serves as a solutions library, offering information on past failures (symptoms) and corrective actions (solutions) taken. Field engineers are provided part, product, and customer system maintenance information. Maintenance time is decreased since time is not wasted on a problem that was previously solved.

19. A computerized field service MIS facilitates the tracking and analysis of field engineer activities.

All the companies studied utilize management information systems to maintain customer account information, perform dispatching functions, and track field service activity. Three companies (IBM, Amdahl, and GECS) utilize only one field service MIS, and two companies (Amdahl and GECS) incorporate parts tracking into the field

service system. If more than one system is used (for field service and/or parts management) an interface allowing automatic information update is required.

Field engineers enter a variety of information into the management information system through service activity reports: field engineer identification, machine type/serial number, time service call was placed, travel time, time of arrival, duration of call, duration of fix (actual maintenance time), type of fault, failed part number, problem description code, and maintenance activity codes. Reports (either ad hoc or formatted) are available from the system(s) to assist field service management in the evaluation of field engineer performance. The performance of individual field engineers can be tracked against nationally established averages to identify out-of-tolerance variances.

As previously discussed, some of the information is shared with other company functions while portions are retained in the solutions database.

20. Field service maintenance activity information provides an indicator of customer satisfaction.

The information input by the field engineer allows field service managers to indirectly gauge customer satisfaction. By comparing field engineer performance with customer contract specifications, an indirect measure of customer satisfaction is determined.

Service Parts

21. The management of electronic service parts should be centralized.

22. High use parts should be stocked as close to the customer as possible to provide minimum customer down time.

23. Low use, high dollar value parts should be stocked in strategic locations and rapid transportation utilized to respond to customer needs.

Ramsburg and Harshberger (1990) note that the costs of computer parts have escalated dramatically since the late 1970s. The average individual part cost has increased over 300 times for small systems and 750 times for large systems. Inventory management is the challenge of the 1990s and the key to the management of service parts is the ability to track and rapidly move the parts. An integrated MIS "is a must to provide total visibility" (p. 39). The authors also advocate the centralization of all the processes necessary to manage service parts into one facility and providing that facility with access to a rapid distribution network. On average, the cost of rapid parts delivery is more than offset by the increasing cost of parts.

Voss et al. (1985) notes that "the availability of a good MIS and good transportation can generally allow lower stock levels" (p. 155). Lower stock levels (to include safety stock) are achieved by centralization to minimize duplication of stock or through the use of cross-shipping of decentralized stores. For electronic products in

particular, central stocking and the use of air express delivery offers minimum handling and less damage when compared with slower, over the road transportation (Williams, 1988).

In the electronics industry (and in particular the computer industry), parts obsolescence due to rapidly changing technology is a major problem. The need to maintain minimum inventory levels to meet customer service levels is critical. Parts that become obsolete must be disposed of or modified. Both disposal and modification result in additional (and sometimes unplanned) expense. Obviously the minimization of inventory levels minimizes the number of parts subject to obsolescence. Centralized parts management and stocking, rapid transportation, and the implementation of JIT and buffer management (see proposition 25) all contribute to minimization of inventory.

Centralized service parts management is practiced by all six companies. In general: parts are stocked at a centralized depot which supplies replenishment orders and emergency orders (orders which can not be filled locally) to lower stocking echelons; high-failure, high-use parts are stocked close to the customer; stocking locations remote from the customer stock lower failure, higher dollar parts. In four instances, automatic replenishment ordering from the centralized stocking facility is utilized. The rework of repairable parts (returned from field locations) is also centrally controlled; in five of the companies, the repair

process is initiated when a demand is levied on the parts management system. Amdahl is the exception, repairing parts immediately upon return to the rework facility.

To service the customer, the right part at the right place at the right time is required. If a field engineer does not have the required part to affect a repair, that part must be located. Parts visibility (through computer tracking) allows the rapid identification of a part's location; rapid transportation gets the right part to the right place. All companies utilize rapid air transportation (overnight and/or 4-hour air) to move emergency orders, or parts not available "locally." Generally, parts available locally (in the same metropolitan area or other nearby geographical area) may be cross-shipped from one stocking location to another by a local delivery courier (e.g. AT&T's Hotshot service) or picked up directly by the field engineer.

24. Accurate forecasting, high visibility, and automatic replenishment (pull) of parts requires extensive computer power.

Lee and Steinberg (1984) found that the forecasting of service parts requirements was a major concern of service parts managers due to their inability to forecast accurately. Forecasting of service parts requires computer power to allow constant update, real time review, and to provide a detailed usage base. All six of the companies studied track service parts and service activity via a

management information system(s); a detailed, historical parts usage (failure) database is maintained which is central to the forecasting of service parts requirements. The close coordination of marketing and field service provides updated inputs to the installed equipment database, a critical factor in determining parts requirements. The cross-flow of information resulting from multi-functional teams and the sharing of field service information through access to the field service management systems provide the means to accurately forecast requirements for new and existing products. For example, marketing inputs provide current and projected product sales; reports from engineering are required to determine reliability of components and projected failure rates; daily field service activity reports provide a means to compare projected versus actual use. An additional factor, the product life cycle and associated stop support provisions, must also be considered.

Four of the six companies utilize automatic parts replenishment; four also utilize air transportation for replenishment orders. An effective field service management information system should allow automatic parts replenishment by air transportation. The traditional concept of lot sizing must be modified: instead of one lot consisting of a number of the same parts, lots would consist of a number of different parts destined for a common location or a single field engineer. A field engineer will

report parts usage for a specified amount of time; at the end of the time period, an order of all parts used will be prepared at the central replenishment location and shipped to the field engineer (or lower stocking location).

25. A pull system should be utilized throughout the logistics pipeline.

Amdahl, GECS, and Hewlett-Packard use one-for-one (pull) replenishment for all stocking echelons below their centralized, national centers. AT&T, IBM, and NCR use some form of ROP/EOQ for replenishment of all echelons except the lowest--field engineers order one-for-one. (Reference Table V-7.) The emergency parts order system for all six companies is a pull system. A pull system utilized throughout the logistics pipeline would seem to offer substantial inventory reduction benefits.

At the national level, the companies studied receive parts from rework facilities, manufacturing plants, or parts vendors. At this level, ROP/EOQ is utilized by all companies. Just-in-time (JIT) production and purchasing techniques could be utilized to replace the current ROP/EOQ practices. Blumberg (1989b) states that full control of the total logistics pipeline is a major mechanism for improving field service productivity and efficiency and that "the management of the total logistics pipeline can significantly reduce the level of inventory investment required" (p. 21). A portion of this pipeline is the refurbishment and rework of repair parts. Blumberg notes that JIT "control and

scheduling of the depot rework and refurbishing operations can . . . significantly improve productivity and efficiency of the logistics operations" (pp. 21-22).

In his case study of the Westinghouse Electric Distribution and Control Business Unit, Moore (1988) noted that JIT manufacturing practices, coupled with streamlined order processing, highly efficient order picking, computerized inventory data (usage) collection, and the use of rapid transportation resulted in significant inventory reductions. JIT manufacturing was noted as a "key element in Westinghouse's inventory control success" (p. 215). All of the six companies examined in this study possess the supporting elements; only JIT manufacturing policies and practices are lacking.

Schonberger (1982) points out that to the Japanese, purchased inventories are as evil as in-plant inventories (p. 157). JIT purchasing is characterized by frequent deliveries and small delivery lot sizes; ideally zero inventory is held "via one-at-a-time continuous delivery from supplier to user" (Schonberger & Gilbert, 1983, p. 56). JIT purchasing of materials is as appropriate for repair parts inventories as it is for manufacturing inventories; the benefits are the same: lower inventory levels and lower inventory costs. Utilizing JIT remanufacturing (rework and refurbishment), manufacturing, and purchasing practices can yield inventory reductions at the national stocking level.

When transportation economies preclude same-day delivery of repair parts, the concepts of inventory buffers and buffer management can be applied at all stocking echelons to protect customer service levels. According to Schragenheim and Ronen (1991): "The purpose of a buffer . . . is to protect a schedule--meaning, to ensure that the scheduled parts will be where they are needed at the time they are needed" (p. 74). Although their discussion deals primarily with a manufacturing environment, repair parts must also be "where they are needed at the time they are needed."

Buffer management compares the actual buffer inventory usage with planned usage and makes adjustments as necessary. Initial buffer inventory levels for repair parts are established based on sales and engineering forecasts (e.g., anticipated sales, projected failure rates, estimated repair times) and parts order/delivery lead times. As actual consumption occurs, the size of the buffers may be adjusted up or down to protect desired customer service levels. For the companies studied, the availability of a historical parts usage database and the real time reporting of usage would facilitate the buffer management process. Additionally, the need for detailed parts forecasts would be eliminated since the buffers are replenished based on actual use--when a part is used, another is "pulled" to fill the "hole."

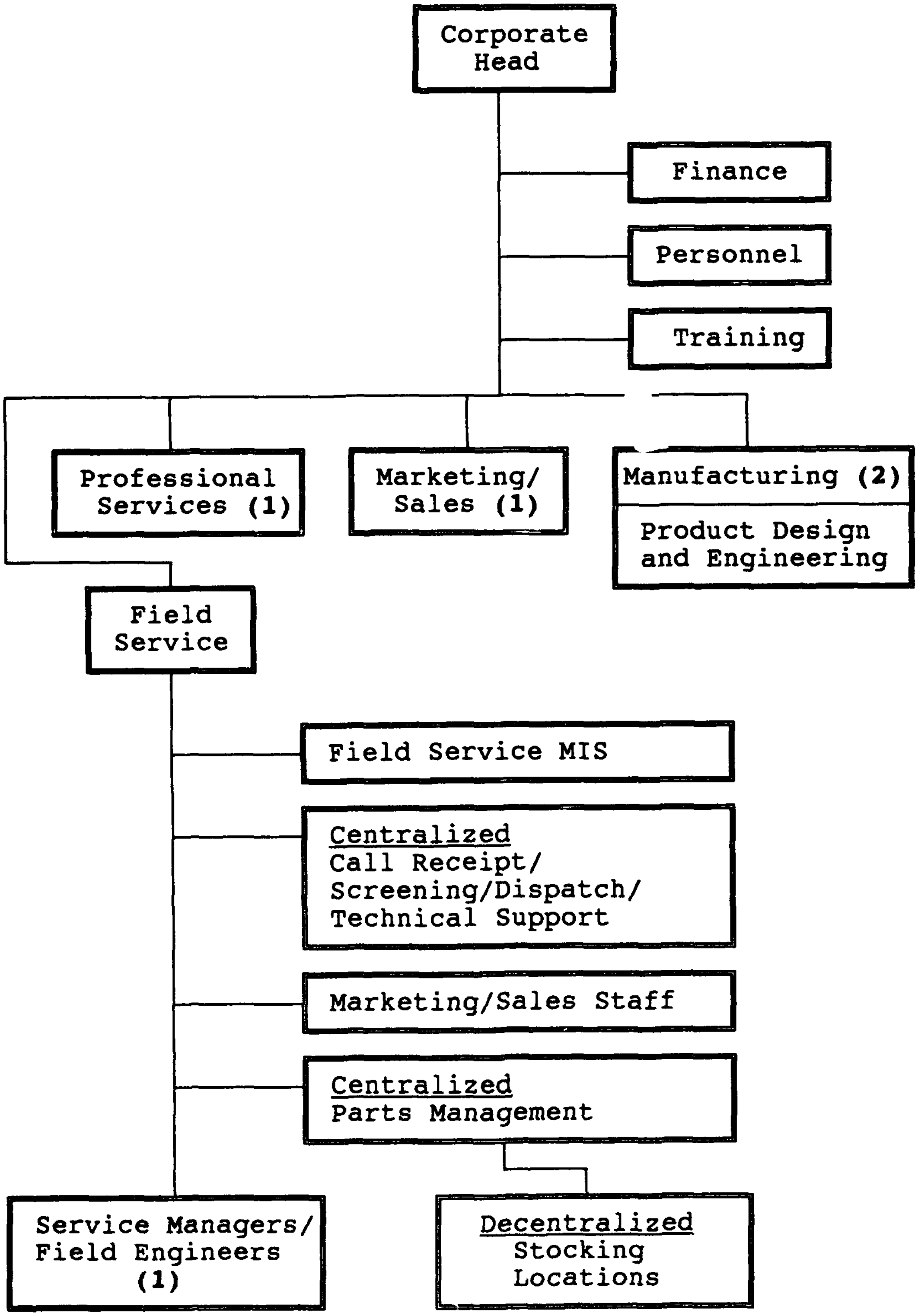
Field Service Model

The field service model developed for this study is portrayed in five sections (components): (a) the field service organization (and its placement within the company), (b) field service strategy considerations, (c) the field service operations flow, (d) the management information system (including feedback channels for performance measures), and (e) the flow of service parts.

Field Service Organization

The overall organization for a company in the electronics industry--a company that manufactures electronic products and provides field service support--is depicted in Figure V-7. This model portrays field service, professional services, marketing/sales, and manufacturing as major groupings under a company head.

Field service is recognized as a competitive differentiator in the electronics industry (Arthur, 1990; Blumberg, 1989b); it requires an equal relationship with marketing/sales and manufacturing. All of the companies included in this study recognize the need for close coordination between the three functions. Field service personnel work closely with marketing to provide a "complete" solution to customer requirements--the right product/system and the required level of support matched to the customers' needs. Field service personnel are assigned to research and development labs and manufacturing plants to



(1) Co-located at geographic, local offices (decentralized).
(2) Co-located field service representatives.

Figure V-7. Field Service Organization.

provide maintenance expertise and to assure serviceability of products.

Although beyond the scope of this study, it would be remiss not to note that many companies are currently supplementing their field service (hardware) offerings by developing new forms of service: consulting, systems integration, software support, training, and catastrophic backup. This trend in the expansion of services has been noted by Arthur (1990), the Association For Service Management International and Arthur Andersen (1988), Blumberg (1989b), and Smith (1989). The professional services offering by IBM reflects this new emphasis on expanded services and the name was chosen to represent this function in the model. Blumberg (1989b) suggests that in the future, field service and professional services will merge into a strategic line of business and will require a separate strategic planning and marketing staff "focusing on the special requirements for marketing, merchandising, and selling service and establishment of service prices" (p. 26).

Concerning the field service group, the use of centralized support functions is practiced by each of the six companies. Financial, personnel, and training support is generally centralized at the company level to support the widely dispersed field service work force. Financial and personnel matters can generally be resolved over the phone

or by other electronic means (modem link, facsimile). The expense of "hands-on" computer equipment necessitates centralized (national or regional) training facilities. Centralized training is supplemented by training aids at field service office locations: video tapes, computer-assisted instruction utilizing optical storage compact disks (CDs), and satellite links.

At the heart of the field service organization is the field service management information system (MIS). (If more than one system is used to track field service engineers' activity, parts usage, customer files, etc.; all systems must be integrated to allow updates in one system to automatically update all systems.) This system meets a variety of needs--information must be shared and available to numerous personnel: field service managers to track and evaluate field service activity; manufacturing, engineering, and parts personnel to determine actual failure rates of parts and components; marketing personnel to determine service offerings and pricing.

Call receipt, call screening (service call avoidance), dispatch, and technical support may be centralized na ionally (Amdahl, AT&T, GECS) or by major geographic regions (IBM, HP, NCR). (The model depicts national centralization.) These four functions represent an interface with the customer: (a) the service call is placed by the customer utilizing a toll-free number, (b) call receipt personnel document the problem, (c) engineers at the

central location work with the customer and attempt to solve the problem over the telephone, (d) if necessary a field engineer is dispatched to the customer's location.

Technical support personnel are often the same people who perform call screening; they are also available to provide assistance to field engineers experiencing on-site maintenance problems. Technical support personnel are highly trained, have extensive maintenance experience, and often specialize in specific products. In a sense they represent the company's corporate body of maintenance knowledge; centralization provides national access to their expertise.

A field service marketing and sales staff is recommended to plan and coordinate service selling; this organization maintains a close liaison with the company's marketing/sales organization and field service managers. The staff's function is to insure that service offerings and capabilities are properly synchronized with product sales--the "common face" to the customer concept.

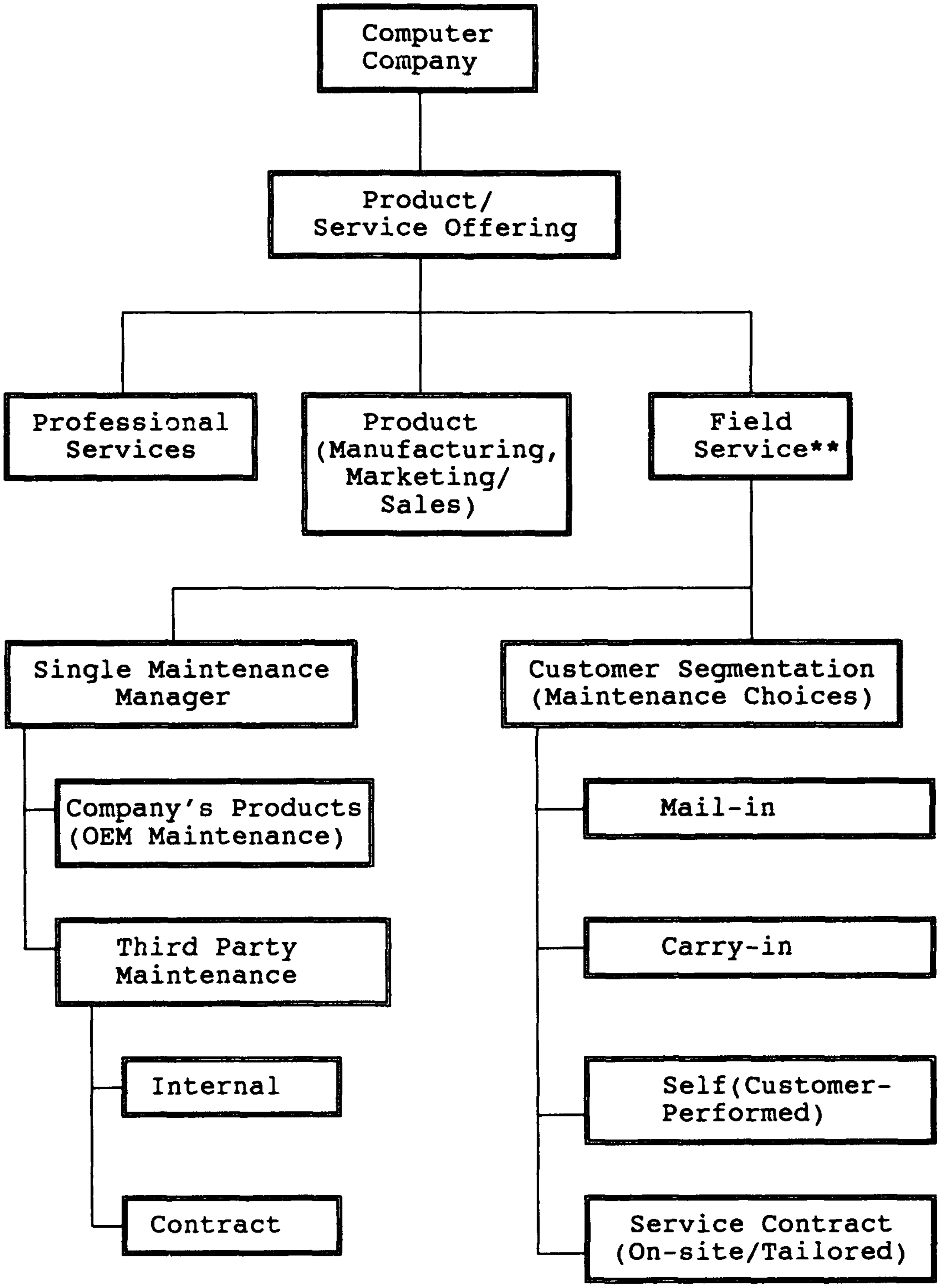
Service parts and parts rework are centrally managed and are grouped under the heading of "Centralized Parts Management." Service parts are centrally stocked utilizing rapid transportation modes to respond to emergency orders (parts unavailable for repair at customer location) placed by the decentralized field service work force. Field engineers' stocks and stocks at dispersed geographical locations (strategically located to provide backup for field

engineers) are replenished from the central stocking location. In general, to reduce inventory investment while maintaining desired customer service levels, high failure items are stocked close to the point of need (customer) with low failure, high value parts stocked at regional or national locations.

Field Service Strategy

Over the years, incremental purchases of computer hardware in response to company expansions or changing requirements coupled with a mixture of hardware required for special applications (mainframe versus personal computer work stations) have resulted in systems composed of products from a variety of manufacturers (original equipment manufacturers or OEMs). A variety of manufacturers generally meant a variety of OEM service contracts. Additionally, the critical importance of computer systems in today's business environment has increased the demand for minimum down time and rapid maintenance response and problem resolution. These two factors, a mixture of hardware (and support contracts) from numerous manufacturers and an increasing emphasis on maintenance support, have lead customers to demand nationwide, single-source, rapid, and reliable service support. After-sales support (maintenance) is also becoming an important consideration when purchasing computer hardware and peripherals.

Field service strategy is depicted in Figure V-8. The five computer manufacturers (OEMs) studied recognize that



** Profit center/competitive differentiator

Figure V-8. Field Service Strategy.

maintenance is not only a critical competitive factor in product sales but also an important profit generator in a rapidly growing market--the service market for computer field maintenance and repair services is estimated to grow from $16.41 billion in 1991 to $24.75 billion by 1995 (Blumberg, 1992, p. 63). Today, a computer manufacturer must be able to provide service for its own products (OEM) as well as for those of its competitors (third party).

Third party service may be provided by the internal field engineer work force or through contracts with independent third party service companies (often involving a strategic partnership or alliance). Additionally, customers must be offered flexibility in the form of maintenance choices: mail-in, carry-in, self, or service contract. Customers can choose the most convenient and cost effective mode of maintenance based on their personal needs and business environment. Service contracts for on-site maintenance should also allow customer tailoring. A small business utilizing computers primarily for word processing applications does not generally require the same maintenance response time or guaranteed system uptime as a large manufacturing firm.

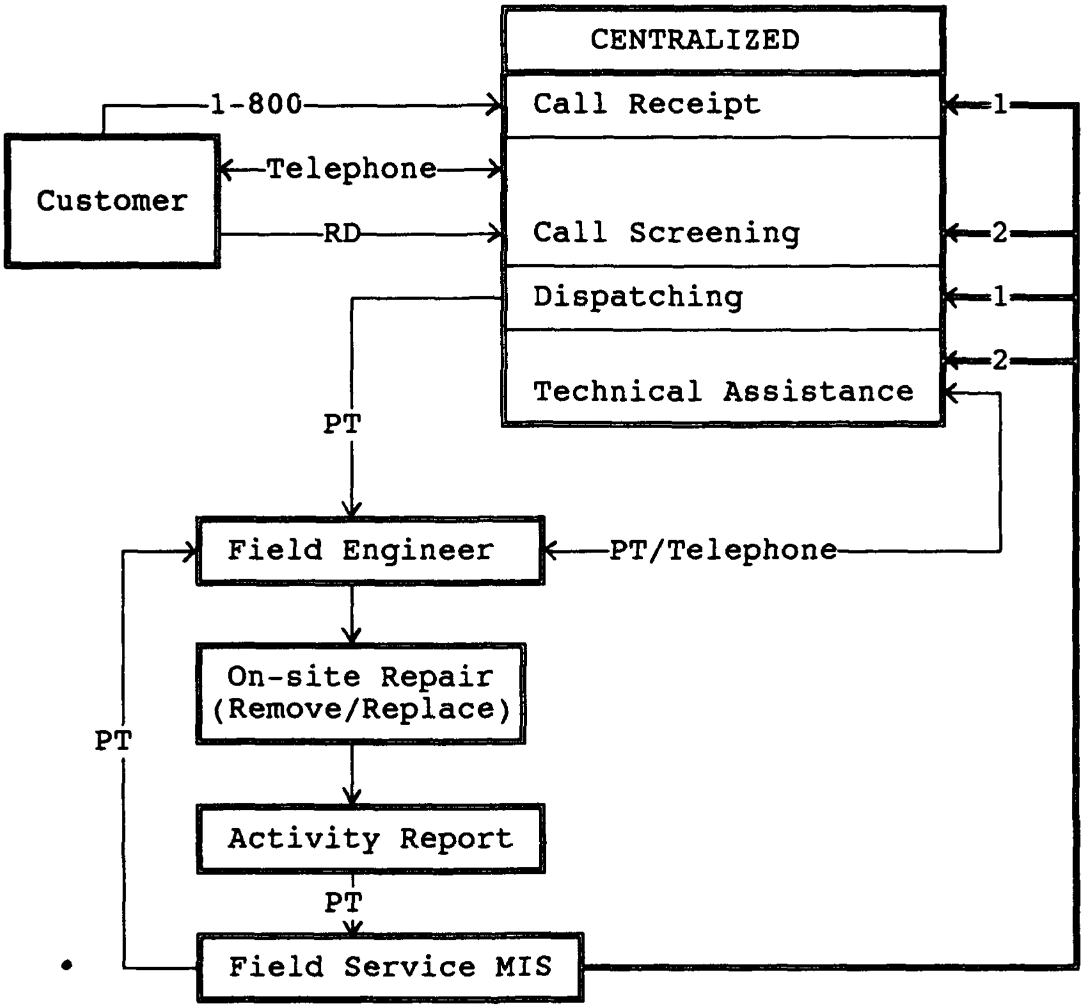
A final consideration for after-sales support concerns the product life-cycle. Life-cycle estimates from marketing and engineering must be used as a basis for instituting field service end of support provisioning. End of support for a product must be planned and advance notice given to

customers. Customers must be provided adequate time to select and budget for replacement equipment and/or to determine a last buy of parts for self-maintenance of the discontinued equipment.

Field Service Operations Flow

The field service operations flow for customers with on-site maintenance options is depicted in Figure V-9. (As previously discussed, in addition to the on-site option, customers may mail or carry in their equipment to repair centers or perform their own (self) maintenance.)

When a problem is experienced by a customer, a toll-free telephone number is utilized to contact the centralized call receipt function. The call receipt function acknowledges the call, accesses the customer's file, and records the problem symptoms. Call screening personnel review the symptoms and discuss the problem with the customer, attempting to screen out non-hardware problems. Software problems may also be detected through remote diagnostics and corrected via electronic commands from the call screening location. If a hardware failure is suggested by the customer's problem description or by remote diagnostics, customer-performed maintenance may be directed over the phone. If the problem cannot be resolved remotely, a field engineer must be dispatched for an on-site repair. Technical assistance, co-located with the call-receipt group, is also available to provide assistance to field engineers experiencing maintenance difficulties.



RD = Remote Diagnostics
PT = Portable Terminal (communication link)
1 = MIS accessed for customer files
2 = MIS accessed for customer files, solutions database

<u>Figure V-9</u>. Field Service Operations Flow.

Field engineers are trained to repair not only their company's products but also those of other manufacturers. (Some companies contract out the repair of other vendors' products to a third party service provider.) Using a remove and replace technique enhanced by modular product design, parts are quickly isolated, tested, and defectives removed and replaced with a new part or component.

Direct access to the field service management information system is provided by portable terminal with a modem or radio communication link. If a part is not available locally, the field engineer can access the field service management information system (MIS), determine the part location, and order the part directly or instruct the local parts clerk to place the order. Direct access to the MIS solutions database (a historical collection of maintenance problem symptoms and solutions) is also available.

When the repair is completed, the field engineer submits an activity report directly into the MIS through the portable terminal. A typical activity report is preformatted and may include: machine type, serial number, travel time, time of arrival, duration of call, actual maintenance time, type of fault, problem description, and failed part number.

Field Service Management Information System

The field service management information system (MIS) was referred to earlier as the heart of the field service

organization--it could perhaps be better described as the central nervous system. The field service MIS is portrayed by Figure V-10. Major inputs to the system are provided by customers, marketing/sales and field service managers, parts management and engineering personnel, and field engineers.

Customer account information includes demographics (e.g. name, address, telephone number); installed equipment type, model, and serial number; service contract specifications (to include billing instructions); field engineer assignments; and service history. Initially marketing/sales personnel create the account; updates to the account (such as service contract modifications, equipment installations, field engineer assignments) are made jointly by marketing/sales managers and field service managers. The account service history is automatically updated based on field engineer activity reports.

Customer inputs to the MIS are indirect through marketing/sales and field service managers. In addition to supplying information for the account file, customers provide performance feedback through the various customer satisfaction surveys and interviews performed by both marketing and field service. All customer performance information, including complaints, should be tracked, analyzed, and compared with national industry averages.

To maintain an interface with the central support services of finance, personnel, and training; field service managers enter local information such as profit/loss

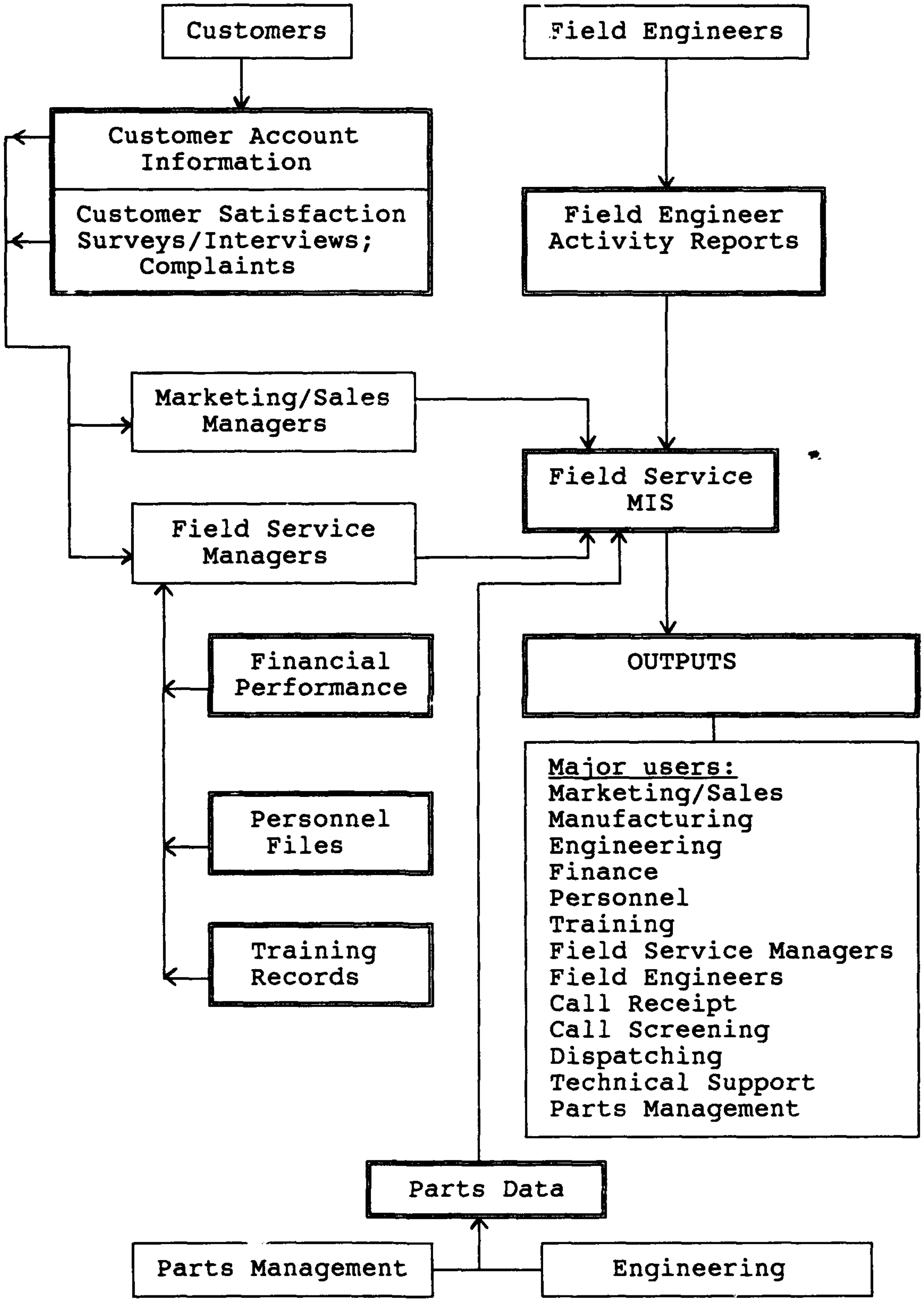


Figure V-10. Field Service Management Information System.

performance, personnel changes, and local training requirements. When entered into the global or centralized information files, finance can compile company reports, personnel can update records, and training can be scheduled on a national basis.

Parts management personnel, utilizing reliability and parts failure data supplied by engineering, create and update the inventory records. (Field service personnel also work with parts management and the engineering section to create initial spares lists.) Inventory records provide the status, location, and availability of parts. Finally, field engineers provide maintenance activity reports. These reports provide a means to evaluate both field engineer and product/part performance.

Outputs from the MIS are many and varied. The call receipt and dispatching functions require customer files for customer identification and to determine field engineer assignment. Access to the solutions database is essential for field engineers and technical support personnel. Engineering is interested in comparing actual part failures with forecasted; engineering changes may be required if excessive failure rates are observed. Parts management personnel adjust stocking levels, revise parts forecasts, and initiate replenishment orders based on reported parts usage. Field service managers extract field engineer performance information and compare it to national standards; variances can then be investigated.

Additionally, an indicator of customer satisfaction is available to service managers through a comparison of field engineer performance with contract service specifications. Virtually every part of the company benefits (or can benefit) from field service information.

Service Parts Flow

Service parts are "consumed" at the customer's site when the defective part is replaced by an operable one. Field engineers report the use of the part in their service activity report; the report is entered into the MIS. If the part is coded as repairable, it is returned to the parts manager at the local office for return to the rework facility. The repair schedule at the rework facility is controlled by a centralized parts management group; parts are sourced from the repair facility when a reorder point is reached. New parts enter the system from the OEMs manufacturing plants or from other vendors if third party parts are stocked. Like repair parts, new parts orders are based on reorder points and are centrally controlled.

The field service activity report triggers an automatic replenishment order from the central stocking location to the location that actually supplied the part. For example, if the field engineer placed an emergency part request and the part was shipped from a regional depot, the depot would receive the replacement part.

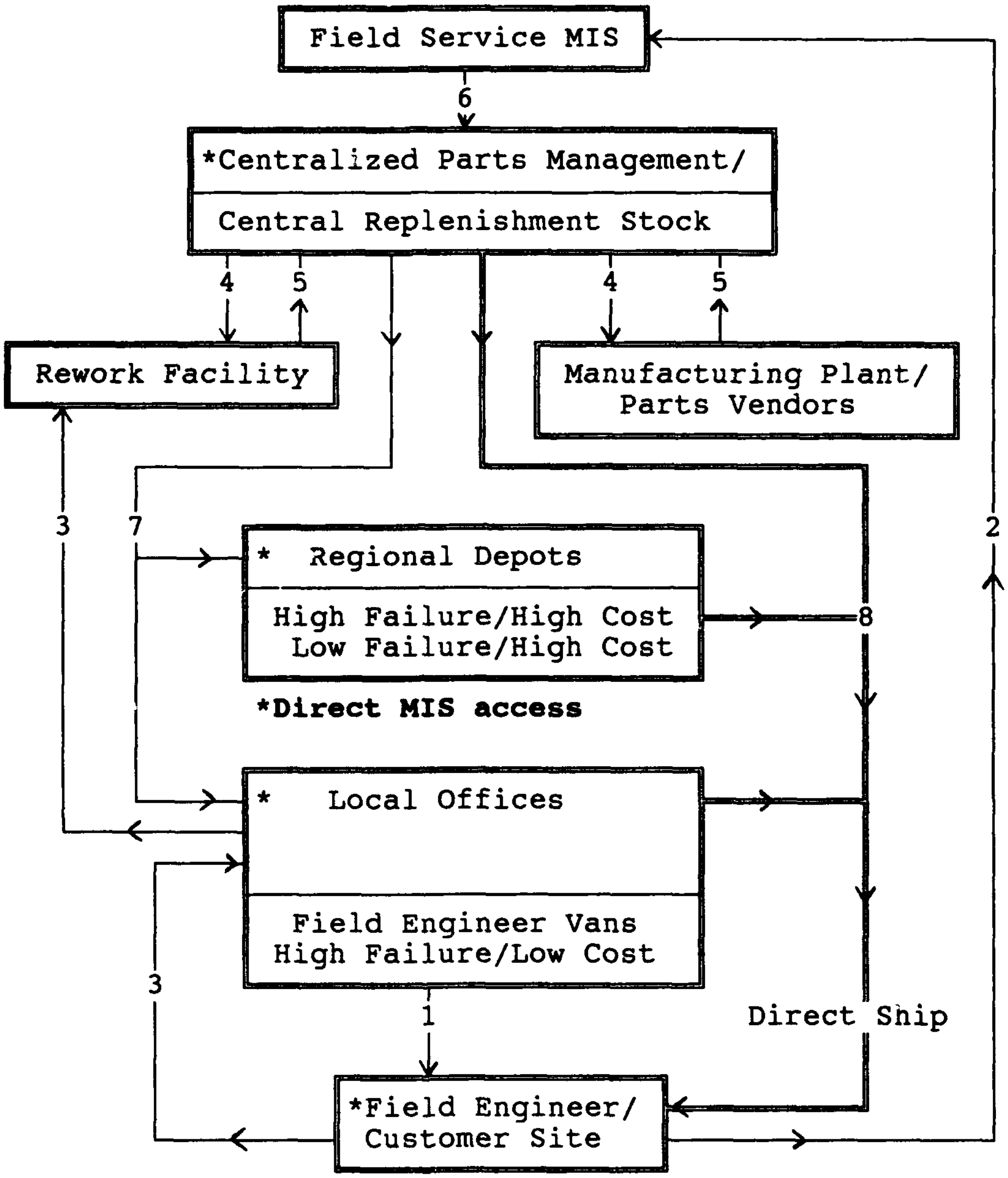
Emergency parts (parts not available in the field engineer van or local office stock) requests can be entered

directly into the MIS through the field engineer's portable terminal. Emergency parts are shipped by rapid air transportation from regional depots (primarily) or the central stocking location. Regional depots are strategically located to provide backup to the local offices. The service parts flow is depicted in Figure V-11.

Model Development and Evaluation

Emory and Cooper (1991) define a model as "a representation of a system which is constructed for the purpose of studying some aspect of the system or the system as a whole" (p. 63). They further state: "Description, explication, and simulation are the three major functions of modeling. Descriptive models seek to describe the behavior of elements in a system where theory is inadequate or non-existent" (p. 64). As noted in Chapter III, this research is classified as exploratory and theory-building using a case study research design--a model of the field service system was developed from case data.

Schendel and Hofer (1979) state that in a developing field, a phenomenon must be adequately understood or described (explored and concepts developed) before moving to hypothesis generation and testing. They agree that descriptive research is required in such a situation but add a qualification: "Also, make the research normative. As long as one is observing practice, examine the best practice when possible so that it is known to be worth emulating" (p. 386). Schendel and Hofer further state:



1. Part used for customer repair.
2. Parts usage/emergency request reported by Field Engineer.
3. Reparable parts returned to Rework Facility.
4. Repair schedule/new parts orders controlled by the Centralized Parts Management Facility.
5. Parts shipped to Central Stocking Facility.
6. Parts usage/emergency request extracted from MIS generates automatic replenishment order/emergency order.
7. Replenishment orders shipped.
8. Emergency orders shipped via rapid air transportation.

Figure V-11. Service Parts Flow.

> Descriptive research aims only at describing "what is," that is, at developing a model of phenomena that are observed or identified. By contrast, the purpose of normative research is to help develop prescriptive theory. It attempts to describe what "can be" insofar as any given "can be" is possible in the real world. (p. 388)

In a sense the field service model presented is based on both descriptive and normative research--descriptive in that the model represents what has been observed and prescriptive in that it represents "best practice" of leading electronics field service firms.

It is assumed that the application of "best practice" techniques identified in the model will assist field service managers in improving their current operations. "By definition, prescriptive theories must contain variables controllable by management; otherwise, there would be no way for management to intervene and 'apply the prescription'" (Schendel & Hofer, 1979, p. 385). The variables represented by the model components--organization, strategy, service operations, information systems (to include performance feedback), and service parts management--are all within the control of management.

For any model to be of value, it must accurately represent the phenomenon under study. Additionally, to be of use, a model must be easy to understand and to implement. The model developed is based on similar practices of the six companies. These practices, detected through cross-case analysis, are based on the case data and accurately reflect information collected from interviews, questionnaires,

on-site observation, and a review of the literature. The model is simple, utilizing boxes to represent activities, functions, inputs, and locations. Lines and arrows are utilized to indicate important relationships and flows. A field service manager should have no problem following the logic of or understanding the terms used in the model.

The model represents a general overview of the field service system; specifics on the implementation of concepts embodied in the model are not provided and would require additional research by field service personnel. For example, if a company wished to implement regional stocking locations for high value parts and utilize rapid air transportation, the procedure for determining stocking costs/transportation costs/customer service levels tradeoffs is not provided. Specific types and quantities of parts to stock at the regional locations would be company specific depending on the installed equipment base supported, parts failure data, and the distance to local offices. Overall, the model provides the ends but not the specific means for implementation. An accurate evaluation of the model will require review and use by both practitioners and academicians.

As noted in Chapters I and II, few field service case studies are available and a systems perspective of field service is lacking. This study identified major field service system components and documented the practices of leading electronics field service companies in those

component areas. Additionally, the model portrays interdependencies between the components. For example, the field service management information system is utilized for parts tracking, to support field engineer operational reporting, and to provide service information to other company functions. Strategy decisions affect the size and composition of the field engineer force, parts support procedures, and organizational structure. Overall, the resulting model serves as a guide to improve a company's field service operations and to achieve "world class" status.

CHAPTER VI

SUMMARY AND CONCLUSIONS

This chapter presents a summary of the dissertation effort, discusses limitations of the study, and finally, presents conclusions.

Dissertation Summary

Although field service has been noted as a competitive edge, information on the subject of field service is lacking; what information is available is fragmented and lacks a system perspective. An exploratory methodology, utilizing case studies, was selected for this study. Firms selected for the study are field service leaders in the electronics industry. The electronics industry was chosen due to the emphasis on and the importance of field service to competitiveness; industry leaders were chosen to document "best practice." Firms selected were recommended by field service consultants, practitioners, and personnel from national field service professional associations. Various industry rankings and surveys were also utilized to identify exceptional field service performers.

Data was collected primarily through on-site interviews with field service and marketing managers from the various companies. Notes were taken during the interviews; additionally, most interviews were tape recorded. On-site

interviews, telephone interviews, facsimile transmissions, and mail correspondence were also utilized to gather data from other parties (recommended by the primary interviewees) and to correct any discrepancies. A standard set of specific questions, designed to answer the six research questions and to provide consistency, was used to conduct each interview. Wherever possible, company documents were also reviewed to cross-check and expand information.

The study was undertaken to answer six research questions:

1. How is the field service function organized?

2. What is the field service strategy and how does that strategy contribute to the overall company strategy?

3. What performance criteria, standards, and measures have been set to evaluate field service performance?

4. What service processes make up field service operations?

5. How is the management information system organized within the field service organization and what information interfaces exist with other company functions?

6. What logistical techniques are used to manage service parts?

The answers to the questions, organized into six case studies and subjected to within-case and cross-case analysis, allowed the identifications of 15 field service management propositions (generalizations) and the development of a general model of the field service system.

Limitations of the Study

The case study methodology is well-suited to new research areas and is "especially appropriate in new topic areas" (Eisenhardt, 1989, p. 548). Case studies, consisting of empirical data collected from a variety of information sources, provide a systematic means to study phenomenon. Validity and reliability issues can be addressed by utilizing a variety of tactics: multiple sources of data and multiple methods of investigation, member checks, replication through multiple case studies, cross-case analysis, and the creation of a case study database.

The methodology is not, however, without limitations. Purposive sampling was utilized in this study--companies were selected based on industry leadership and only one industry, electronics, was examined. A sample was chosen based on Merriam's (1988) recommendation "that one needs to select a sample from which one can learn the most" (p. 48). The sample size was limited to six. Eisenhardt (1989) recommends between 4 to 10 cases to avoid lack of empirical grounding (fewer than 4) and to avoid overwhelming data complexity and volume (more than 10). Although a comprehensive understanding of the six companies' field service activities was achieved, the generalizability of the research results to other field service operations, both within and outside of the electronics industry, is not implied.

Another limitation, common to all research but of particular concern in field research, is data accuracy. A variety of information sources and data-gathering techniques were utilized: company literature consisting of marketing brochures, sample contracts, internal company reports, and company annual reports; personal interviews with marketing, field service, parts management, and corporate management personnel; and telephone interviews with various management levels. Follow-up calls, facsimile transmissions, and additional interviews were conducted to cross-check data and to resolve discrepancies. Applicable sections of the cases were mailed to the various participants for review and verification.

It was noted in Chapter III that this research was a theory-building versus a theory-testing effort. Theory building from case studies is characterized by two weaknesses: overly complex theory, lacking parsimony and narrow, idiosyncratic theory (Eisenhardt, 1989). The amount of data collected leads the researcher to build complex theory which encompasses everything, missing the simplicity of the overall perspective (p. 547). The careful application of within-case and cross-case analysis allows one to overcome the first weakness. Both within- and cross-case analysis were conducted to identify major data patterns and to generalize these patterns across the cases. The development of empirical generalizations, or propositions, from the patterns and the presentation of a field service

model further served to simplify findings and to provide an overall, system perspective.

Narrow, idiosyncratic theory is a limitation of this research. The data which suggested the propositions and model came from one section (industry leaders) of one industry (electronics)--the goal of the study was to identify "best practice." The lack of generalizability both within and outside the electronics industry has previously been stated.

Conclusions

In general, there were more similarities than differences among the firms studied and many of the differences can be explained by a differing computer market focus. These similarities might be expected due to the focus on a specific industry (electronics) and the selection of industry leaders who are assumed to exhibit "best practice."

Based on this research, it is apparent that field service is information and technology intensive. A computerized management information system (MIS) is the heart of field service operations and support. An integrated MIS and its associated databases are critical to all aspects of field service, providing support to a variety of functions: dispatching, field service activity reporting, performance measurement, parts management, engineering changes/upgrades, technical support. Typically field service information is provided to marketing/sales,

manufacturing, engineering, and research/design. A two-way communications system, providing field engineers with rapid access to field service databases, is also essential.

In comparing the results of this research with the field service problems and concerns expressed in the literature review, it appears that for the companies studied, these problems are minor or non-existent. The fact that these companies recognize the importance of field service to their overall company competitiveness perhaps accounts for this. The field service maintenance market for high-technology electronics is estimated to be about $32 billion in the United States and almost $100 billion worldwide (Blumberg, 1991, p. 21). In the electronics products service industry, field service is a recognized contributor to corporate revenue and profits--for equipment vendors, service contributions average 26% of total revenue and 50% of total profit (AFSMI and Arthur Andersen, 1988). Firms operating in this type of a competitive environment cannot afford to treat field service operations as an "afterthought," "add-on," or "necessary evil."

These firms have also avoided the problems identified with service parts management. Intensive parts tracking systems allow more efficient forecasting and provide visibility throughout the logistics pipeline. In all instances, the companies exercise centralized control over inventory planning and distribution. In some cases, this centralized control coupled with rapid transportation has

allowed reductions in inventory while increasing customer service levels. Since field service is an important part of the company's business strategy and service parts are required to support field service, parts receive intensive management and attention.

Overall, the six companies are dedicated to customer service. Customer service, facilitated by a team approach, is a part of the company culture. Product design decisions are made by multi-functional teams; reliability and serviceability are designed into the products. Products are also designed to facilitate the rapid removal and replacement of components. Advanced technological tools are utilized to keep the customer's equipment operational or to return it quickly to an operational state in case of failure. Marketing/sales and field service personnel work together to understand the customers' needs and to provide both product and service solutions. Performance measures address not only financial but also customer satisfaction concerns. In each case, the focus is on the customer.

The results of this study, though limited to electronics firms, should provide some insight into field service management principles for practitioners in both the electronics industry and other industries. For researchers, it provides a starting point for future research of the entire field service system or each of the individual subject areas identified by the model. Future research will

be necessary to test the propositions and to validate the model.

Suggestions for Future Research

This dissertation was an exploratory, theory-building effort. The six case studies, analysis, propositions, and model begin the process of providing "usable knowledge, knowledge by which managers can make judgments and decisions" (Miller & Graham, 1981, p. 564). Using Schendel and Hofer's (1979, p. 387) conceptual overview of theory building and theory testing as a guide, future research should focus on: refining and verifying the model and propositions, hypothesis generation, and finally, theory testing.

Two approaches to future research are suggested: (a) additional case studies of leading-edge field service firms (not limited to the electronics industry and expanded to focus on the relationships among the system components previously examined), and (b) the use of questionnaires, based on the current research findings, to expand the sample size. The study of leading-edge companies from different industries would assist in the verifying and refining of research findings and in the development of hypotheses. Additionally, the generalizability of the propositions, model, and hypotheses would be enhanced (assuming the same findings resulted).

Questionnaires, sent to a cross-section of field service firms (firms exhibiting a range of performance

versus exclusively industry leaders) in a variety of industries, would increase the availability of data for statistical analysis. Questionnaire data would provide the basis for theory testing, providing a means to check theory validity and applicability.

When utilizing a systems approach to research, the scope of the research is global and tends to focus on the "forest" and not the "trees." When the research concludes and the final report is prepared, some of the "trees" stand out as more important than others and suggest to the researcher additional areas of inquiry. The two approaches to future research previously suggested are general in nature; more specific research suggestions are discussed in the remainder of this section.

Of the six research areas investigated in this study, three stand out as candidates for future research: (a) strategy, (b) management information system, and (c) service parts. The order of listing corresponds to the priority assigned for initiating the research.

In the area of strategy, proposition seven requires further investigation: Field service representatives must participate in product design, development, support, and modification. This is a critical factor that allows the incorporation of maintainability into initial product design and into any product modifications. The experience of field engineers, both first-hand through representatives on design teams and through service call report information,

contributes to reliability and design improvements. A more thorough study of the process that takes place--the sources and exchange of field service information, the interface between design team members, a description of the role the field engineer team member plays--is required.

All companies state that field engineering input is utilized in the product design, development, support, and modification processes. On-site observation of these processes, with an emphasis on the role of the field engineering team representatives, is suggested. Additionally, an interview with these representatives is recommended to solicit their perceptions on the value and importance of their participation. In particular, is field service an equal partner with marketing, manufacturing, and design engineering?

Field service is information intensive. A computerized management information system is required to process, transmit, and store the field service data. A more detailed, technical analysis of the entire management information system is required. This study focused on the organization and interfaces of the system; a technical analysis of the hardware, communication links, and software utilized, as well as identification of specific information requirements, were beyond the scope of this study.

Field service is information intensive; it is also parts intensive. With a remove and replace maintenance strategy, having the correct part is vital to maintaining

customer service levels and customer satisfaction. However, due to the high cost of electronic computer parts, a balance between inventory costs and service levels is a major consideration.

As previously noted in the discussion of service parts management, the application of JIT production and purchasing techniques as well as buffer management practices should offer inventory reduction benefits throughout the logistics pipeline. Research to develop an implementation plan and to assess the impact of these applications on both inventory costs and customer service levels is recommended. Impact assessment could be accomplished utilizing computer modelling.

In addition to this study's specific research areas, some additional, related areas of interest are suggested. Internal company performance measures were the focus of this dissertation. In order to compare performance among companies, the application of SERVQUAL service quality measures (Zeithaml, Parasuraman, & Berry, 1990) would provide a means to measure customer perceptions of service quality. Companies could be evaluated on a common customer satisfaction scale and this rating compared to the companies' perceptions of customer satisfaction (as determined by their internal measures). SERVQUAL rankings used in conjunction with service revenue measurements would also provide an improved indicator of industry leaders for future research.

Expansion of the research and refinement of the model and propositions are required. By selecting and ranking additional field service leaders (utilizing service revenue and customer satisfaction rankings), companies which are the "best of the best" can be identified. The next step in the research process would be to determine why they are the best. The determination of "why" goes beyond the scope of this study's cross-case analysis. The focus on "why"--the relationships of the system components to outstanding performance--moves the research into the hypothesis generation stage. Structure/strategy interaction and quality (product and service) processes and procedures are offered as two areas for research focus.

A Note on AT&T

The 1989 AT&T Annual Report stated that the company had reduced its work force and created a new business unit structure designed to make the company more competitive and customer focused (p. 2). The report also noted that: a company priority for the 1990s was globalization (p. 3); computer networks were "becoming as important to businesses as telephone networks are to people" (p. 9); interpersonal computing was growing by 40 percent annually (p. 9); and the current configuration of business units was subject to change as new market opportunities emerged in the 1990s (p. 3).

In 1991, to enhance competitiveness, to pursue the globalization effort, and to expand its computer service

capabilities, AT&T acquired the NCR Corporation. Most of Computer Systems' operations were duplicated by NCR and on October 21, 1991, AT&T Computer Systems was deactivated.

The manufacturing function at Little Rock has been transferred to another AT&T business unit. Parts support responsibilities were assumed by NCR's Worldwide Service Parts Center (WSPC) located in Peachtree City (near Atlanta), Georgia. WSPC personnel visited all AT&T stocking locations and reviewed the existing inventories. Required parts were transferred to NCR District Offices or to Peachtree City. Unwanted stock (WSPC personnel believed AT&T carried excessive inventory) was transferred to AT&T's Memphis Distribution Center where a team of AT&T personnel sold parts for salvage or to third party maintenance providers. AT&T Service Centers have been closed and the buildings/real estate offered for sale; most of the AT&T inventory management force has been laid off.

Members of the product teams, the majority of technical support engineers assigned to the Remote Diagnostics Center, and approximately 25% of the field engineer managers have been transferred to NCR. High levels of experience with AT&T products and familiarity with AT&T's UNIX operating systems and related software were major factors used by AT&T to determine who would be retained and subsequently transferred.

Approximately half of the customer engineer (CE) work force was also transferred to NCR. AT&T retained the

remainder of the CE work force, organized under the existing National VP, Service, to perform support of AT&T internal accounts. Union considerations played a major role in the establishment of an internal account support organization. NCR is primarily non-union; AT&T employees are highly unionized. To avoid the possibility of non-union technicians from the NCR service force performing maintenance services in AT&T union shops, an AT&T customer engineer work force was retained.

NCR supplied AT&T with greater access to global computer markets, a third party maintenance presence, and a more sophisticated service parts management network.

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APPENDIX A

Pre-Visit Questionnaire

Please use the following definitions to answer the questions below.

SERVICE PARTS: Parts used for the repair and/or maintenance of an assembled product. Typically they are ordered and shipped at a date later than the shipment of the product itself.

FIELD SERVICE: The function concerned with the servicing and maintaining, by the manufacturer or supplier, of products (usually owned by customers) used away from the manufacturer's or supplier's site. (Sometimes called "after sales service.")

NOTE: IF ADDITIONAL SPACE IS REQUIRED TO ANSWER ANY OF THE FOLLOWING QUESTIONS, PLEASE USE THE BACK OF THE PAGES OR THE BLANK PAGE ATTACHED. THANK-YOU.

1. Name of individual completing questionnaire:

   ____

   Title: ______________________________

   Mailing address: ______________________________

   ____

   ____

   Telephone number: (   ) ______________________________

2. Company name: ______________________________

3. Primary industry: ______________________________

4. Does your company have a single department (or other organizational unit) that is responsible for the management of field service/service parts?

   ___ No
   ___ Yes (Please Describe)

____

____

____

5. Are service parts treated as a separate product line?

   ___No
   ___Yes

6. What percentage of total company profits does field service represent?

   ___%

7. How many service part stocking echelons (levels) does your company have? Please list and briefly describe.

   Number___

8. What forecasting models do you use to determine service parts demand? Please list and briefly describe each.

9. What is/are your company's customer service level goal(s)?

10. What do you feel are the three most important problems or challenges facing your company's field service function?

Thank you for your participation. Please use the space below to make any additional comments or suggestions.

APPENDIX B

<u>On-Site Interview Instrument</u>

Part A: Organization

<u>How is the field service function organized?</u>

1. Organizational chart available? (If not, draw chart.)
   Placement in company hierarchy.
   Reporting channels

2. What is the approximate size of the field service organization?
   Number/categories of personnel

3. Does the field service organization have its own internal support staff?
   If yes, what functions and how many persons in each?

4. What type of organizational approach (or mix) is used?
   Privately owned service company (independent)
   Independent distributors and dealers
   Company owned service center
   National service force
   Service by mass merchandisers (Sears, Penneys)
   Service through OEMs (Stanadyne/GM example; diesel injection equipment)
   Centralized telephone support center (Technical Assistance Center)
   Other (Specify)

5. Which best describes the field service organization?
   Cost center
   Profit center
   Independent business unit (separated strategically and operationally from product divisions)
   Other (Specify)

Part B: Strategy

<u>What is the field service strategy and how does that strategy contribute to the overall company strategy?</u>

1. Does your company have a formal field service strategy? (If no, what is used?)

2. If yes, describe (obtain copy if possible).

3. How does this strategy contribute to overall company strategy?

4. What factors are considered important when formulating strategy? (List, describe)

5. What role does market research play in strategy formulation?

6. How is the market segmented?
   Service only company's products
   Service other companies' products also
   Customer classification system (A,B,C classes)
   Other (specify)

7. What factors differentiate your service from that of competitors?
   Price
   Quality
   Lead time
   Due date performance
   Product/process flexibility
   Innovation
   Other (Specify)
   (Rank order importance. Which are considered order qualifiers and which are order winners?)

8. Is the service/product life cycle considered when formulating strategy?
   New product support (provisioning, parts kits)
   Stop support (last buy offer)
   Support phases
      Pre-production
      Product introduction
      Normal life
      End of production
      End of life

9. How are level of repair decisions made?
   Customer (user) repair
   Remote diagnostics
   Technical Assistance Center (TAC)
   Field Engineer
   Repair Center

10. What role do the following play in overall preparation of field service plans/strategy?

Field Service
Marketing/Sales
Manufacturing
Corporate
Engineering
Finance/Accounting
Administration
Other (Specify)
(Rank order according to importance)

11. What role does field service play in developing plans/strategy of functions listed in question 10?

Part C: Performance Measures

<u>What performance standards and measures have been set to evaluate field service performance?</u>

1. What role do the following play in overall preparation of field service performance standards/measures?

Field Service
Marketing/Sales
Manufacturing
Corporate
Engineering
Finance/Accounting
Administration
Other (Specify)
(Rank order according to importance)

1a. What role does field service play in overall preparation of performance standards/measures of functions listed in question 1?

2. What performance measures are used?
   - Traditional accounting measures (list and describe)
   - Others (list and describe):
     - How were they determined?
     - Customer report card concept used?
       - (performance standards based on key attributes of your service identified as important to customers)
     - Hard/soft performance measures included?
     - Customer service goals?

3. Are all measures quantified?

4. What service quality dimensions are utilized?
   Tangibles: Appearance of physical facilities, equipment, personnel, and communication materials.
   Reliability: Ability to perform the promised service dependably and accurately.
   Responsiveness: Willingness to help customers and provide prompt service.
   Competence: Possession of the required skills and knowledge to perform the service.
   Courtesy: Politeness, respect, consideration and friendliness of contact personnel.
   Credibility: Trustworthiness, believability, honesty of the service provider.
   Security: Freedom from danger, risk, or doubt.
   Access: Approachability and ease of contact.
   Communications: Keeping customers informed in language they can understand and listening to them.
   Understanding the Customer: Making the effort to know customers and their needs. (Zeithaml et al., 1990, pp. 21-22)

5. Are Customer Service Audits used? (Describe, copy available?)

6. Have standard procedures for dealing with customer complaints been established? (Describe)
   How is the complaint procedure communicated to customer?
   What types of complaints are handled?
   Who is notified? How are they notified?
   Who resolves complaints?
   Are complaints categorized, tracked, and analyzed? What categories are used? Who tracks? What type of analysis is performed?
   Is the source of the problem identified?

7. How are performance measures tracked?
   Part of MIS?
   Who receives reports?

Part D: Service Operations

<u>What service processes make up field service operations?</u>

1. List and describe the customer/company processes and interrelationships from customer report of failure to completed repair.

Example:

- Product fails, customer calls
- Service engineer dispatched
- Job diagnosis and repair
- Parts available?
- Finish repair
- Clear job/report repair actions, parts used, time of repair, etc.

2. Is service blueprinting (flow charting) used to analyze the service process? (Copies available?)

Part E: Management Information System

<u>How is the management information system (MIS) organized within the field service organization and what information interfaces exist with other company functions?</u>

1. Describe the field service information system.
   - Purpose/use
   - Inputs
   - Outputs
     - Reports generated
   - How accessed and by whom
   - Data base/files
   - Customer interface/inputs

2. Is the field service MIS integrated with the company MIS?

3. What communication links are used?

4. Is the information system automated (computerized)?
   - Hardware used?
   - Software?
     - Developed in-house?
     - Commercial product (such as Fieldwatch, Super Service System)?
     - Describe

5. What other departments feed information to/receive information from field service? (Regularly, periodically, on exception.)

Marketing/Sales
Manufacturing
Legal
Corporate
Engineering
Finance/Accounting
Administration
Other (Specify)

6. What type of information is exchanged?

7. Is field service used to provide customer intelligence?

How?

Part F: Service Parts

<u>What logistical techniques are used to manage service parts?</u>

NOTE: Logistical system components from Bowersox, et al. (1986); modified by service parts specifics from Patton (1984), Bleuel and Patton (1986), Patton (1986), and Thomas (1987).

Facility structure decisions.

1. Describe the field service parts facilities and their relationships to one another.

Type?
Number?
Size?
Location?

2. What was basis for above decisions?

Forecasting and Order Management

1. Describe the forecasting system used for service parts.

Forecasting model(s)/methods(s) used
Forecasting components
Seasonal, trend, cyclic, irregular
How are forecasts for new item spares developed?

2. Who (or what agency) develops demand forecasts for service parts? (Field service interface?)

3. Describe the order management process.
   What triggers an order?
   Who places the order?

Transportation (Outbound)

1. Modes used:
   Truck (common carrier)
   Company-owned truck fleet
   Rail
   Air Freight
   U.S. Mail
   Federal Express
   U.P.S.
   Other (specify)

2. What are criteria for mode selection?

Inventory

1. Describe the inventory control system for service parts. (inventory records)
   How are service parts identified? (What parts to stock?/Who determines?)
   Inventory levels
      Who sets?
      What basis?
      Lot sizing techniques?
      Safety stock levels/locations?
   Physical counting procedure(s) used?
   How are engineering updates handled? (Configuration management)

2. Describe the inventory tracking system. (stock movement)
   Inventory tracking at various echelons or levels

3. Are service parts managed as a product line?

Repair/Rehab

1. Describe the repair cycle and its management system.
   Parts received for repair
   Tracking of flow through repair cycle
   Return shipment/return to stock
   Precious metals/critical subassemblies reclamation
   Engineering change order (ECO) management and updates
   How long are parts held before repair?

2. How are: level of repair decisions made?
   repair vs. discard decisions made?
   Who makes these decisions?

3. Is ease of repair/replacement an important design consideration for service parts?